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Volume 26 Number 16

Abstracts 38126-40564

August 31, 1972

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Volume 26, Number 16, August 31, 1972

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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. **Griffith, R. V.;** Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 38393, 38829, 38896, and 38897.

38126 (AECL–4146) CHEMISTRY AND MATERIALS DIVISION. Progress Report, October 1–December 31, 1971. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb 1972. 109p. (PR-CMa–19). Dep. NTIS (U. S. Sales Only). AECL $2.00.

38127 RADIOACTIVE TRACERS IN CHEMICAL ANALYSIS. Zmijewska, Wanda (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw); 17: No. 2, 179-215(1972). (In Polish).

Activation and Nuclear Reaction Procedures

Refer also to abstracts 38329, 38338, 38423, 38809, and 39112.

38128 (CEA-N–1536) ACTIVATION ANALYSIS IN WELL LOGGING. Dumesnil, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1 Feb 1972. 42p. (In French). Dep. NTIS (U. S. Sales Only).

Activation analysis has diverse applications in well logging. Measurements made in drillings must be effected very soon after irradiation in a limited neutron flux. Radioisotope neutron sources (^{252}Cf) were used in conjunction with Ge–Li detectors. (France)

38129 (COO–1156-41) USE OF ^{133}Cs AND ACTIVATION ANALYSIS FOR MEASUREMENT OF CESIUM KINETICS IN A MONTANE LAKE. Hakonson, T. E.; Gallegos, A. F.; Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 1972. Contract AT(11-1)-1156. 22p. (CONF-710501–53). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1972).

The kinetic behavior of cesium was determined in East Twin Lake in the montane zone of the northern Colorado Front Range. The contemplated use of an acute tracer dose of ^{134}Cs was technically feasible but not desirable since the lake is on public lands and used by fishermen. The use of stable ^{133}Cs appeared to have numerous logistic advantages over ^{134}Cs and preliminary studies in the laboratory failed to indicate any major differences in the kinetic behavior of the nuclides at the required concentrations. On September 15, 1970, one kg ^{133}Cs as CsCl was uniformly introduced into the 1.45×10^5 m^3 volume of the 5 ha lake. The initial ^{133}Cs concentration in water was about 1400 times less than the LD$_{50(5\ d)}$ for selected aquatic invertebrates. Samples of water, detritus, seston, vegetation, invertebrates, and trout were removed from the lake at graduated time intervals. Cesium concentrations were measured in approximately 10-g samples by neutron activation analysis. Samples were exposed four hours to a thermal neutron flux of 1.5×10^{12} cm^2/sec from a Triga reactor. After a four-week decay period, the desired product, ^{134}Cs, could be measured in all samples with a 4 × 8 inch NaI(Tl) crystal pulse-height analyzer system. Preliminary kinetic data on cesium burdens in selected components of East Twin Lake are presented. (auth)

38130 (IFA-M–46) PHOTOACTIVATION ANALYSIS OF TANTALUM AND NIOBIUM IN ORES. Galatanu, V. (Institutul de Fizica Atomica, Bucharest (Romania)). 1971. 9p. Dep. NTIS (U. S. Sales Only).

The simultaneous determination of tantalum and niobium contents in ores by photoactivation with the bremsstrahlung beam of a 25-MeV betatron and by high-resolution gamma spectrometry with Ge(Li) detectors is described. Problems of interfering reactions are discussed. (auth)

38131 (KFKI–72-25) DETERMINATION OF THE OXYGEN CONTENT OF LUNAR MATERIAL OBTAINED FROM THE LUNA-16 FLIGHT BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Nad, A.; Cheke, A.; Sabo, E.; Forzats, B.; Zemplen, E. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Mar 1972. 5p. (In Russian). Dep. NTIS (U. S. Sales Only).

The abundance of oxygen was determined by 14-MeV neutron activation in a lunar soil powder derived from Luna 16 sample 16/078. The main abundance in wt% is: 42.1 ± 1.2. (auth)

38132 (RCN–165) DETERMINATION OF SELENIUM IN BLOOD. Japenga, J.; Das, H. A.; Hoede, D.; Zonderhuis, J. (Reactor Centrum Nederland, Petten). Dec 1971. 15p. Dep. NTIS (U. S. Sales Only).

A procedure for the determination of selenium in blood by neutron activation analysis is given. The radionuclide used is ^{75}Se ($T^1/_2 = 120$ d). Chemical separation is performed by precipitation of the element. (auth)

38133 ACTIVATION ANALYSIS. Sakanouse, Masanobu (Kanazawa Univ., Japan); Nakanishi, Takashi; Sano, Hirotoshi; Iwagami, Hiroko; Bando, Shoji. Jap. Anal.; 20: No. 13, 119R-39R(Dec 1971). (In Japanese).

Measurements of radioactivity, Moessbauer effects, activation analysis, analysis by isotope exchange, and analysis of nuclear species are reviewed. On the measurement of radioactivity, explanation is made on NaI(Tl) low-level γ spectrometry, Ge(Li) low-level γ spectrometry, measurement of low-level α particles, β particles, and x rays, track method, and autoradiography. By the track method, measurement is possible for determination of neutron irradiation dose, α particles, and concentration and distribution of nuclear fission products in various samples. On the Moessbauer effect, explanation is made on references, apparatus, and method of measurement, Moessbauer spectra in general, and the Moessbauer spectra of compounds of iron, tin, and other elements. On the activation analysis, explanation is made on references, use of radioisotopes, reactions between photons and nuclei, and examples of application to various physical, industrial, and biological fields. On separation of nuclear species, explanation is made on fission products, adsorption and ion exchange methods of the separation, solvent extraction, chromatography, and other chemical methods. (Japan)

38134 APPLICATION OF COMPUTERS TO NEUTRON ACTIVATION ANALYSIS. Kiso, Y.; Tamai, T. (Kyoto Univ., Osaka). Genshiryoku Kogyo; 17: No. 12, 38-43(Dec 1971). (In Japanese).

Neutron activation analysis coupled with electronic computers has recently enabled simultaneous quantitative determination of a number of elements or simultaneous analysis of many samples. This is true especially for analysis of gamma spectra emitted from radioactive nuclides obtained by neutron irradiation. A few methods used in computers for the gamma spectrum analysis are compared. In determining photopeaks, it is required to process and smooth whole data with the computers, since maximum count rate does not always show the photopeak because of statistical variation. Calculation of area of the photopeaks, which is necessary for determining gamma intensity, is also simply described about two methods, by Covell and by using Gaussian distribution curves. To obtain good results, even optimum irradiation and cooling time are often determined with the computers for the purpose of giving optimum input data to the computers. (Japan)

38135 TECHNIQUES FOR ACTIVE ^{3}He ACTIVATION ANALYSIS FOR CARBON AND OXYGEN. Sanders, William Mort. Albuquerque, N. Mex.; Univ. of New Mexico (1971). 186p. University Microfilms Order No. 72-13,799.

Thesis.

The surface and body concentrations of carbon and oxygen were measured in various materials using ^{3}He activation. Channeling techniques were used to differentiate between interstitial and substitutional location of these impurities. Thin target excitation functions were determined for (^{3}He,p) reactions with carbon and oxygen over a ^{3}He energy range from 2.5 to 9.0 MeV. These data were used to calculate the activation curves for various combinations of incident particle energy, impurity distributions, and material. Information on several computer codes used during this study is presented. (Diss. Abstr. Int., B)

38136 QUANTITATIVE THERMAL NEUTRON ACTIVATION ANALYSIS IN THE MOUSE AND IN HUMAN CADAVER SPECIMENS. Weber, David Alexander. Rochester, N. Y.; Univ. of Rochester (1971). 146p. University Microfilms Order No. 72-14,712.

Thesis.

A quantitative analysis of the thermal neutron (n,γ) reaction products was made in experimental laboratory animals and in human cadaver specimens. An investigation was made to determine the feasibility of thermal neutron activation analysis as a technique for estimating the weights of certain elements in vivo and in vitro. The neutron field was used to irradiate mice and fingers from a human cadaver at low fluence levels. Neutron flux homogeneity in the specimens was evaluated from a series of gold foils and from phantom irradiations. The γ-emitting activation products in the specimens were measured with a nominal 30 cc Ge(Li) detector and a 7″ × 5″ NaI (Tl) detector. The Ge(Li) detector was used to determine the γ-emitting radionuclides resulting from the neutron activation; the NaI (Tl) detector provided the data necessary for determination of the individual component intensities. The reactor provided a constant flux of highly thermalized neutrons with which to perform all sample irradiations. Measurements of the γ-emitting activity in irradiated phantoms indicated that the induced activity was directly proportional to element weight for solutions containing the range of element weights and volumes presented by the tissue specimens. Small local flux perturbations observed in gold foils placed in various regions in the irradiated specimen did not significantly affect this proportionality. Radioisotopes of sodium, chlorine, and calcium were detected in all tissue specimens following neutron irradiation. In addition, a radionuclide of magnesium was identified in the finger specimens and a radionuclide of manganese was identified in the mice. A linear least-squares method of analysis of the activation product data was used to solve for the relative intensities of these contributing radionuclide components. This assay allowed calculation of the weights of the respective endogenous stable elements in the specimens. Duplicate measurements of calcium content were made in selected specimens by atomic absorption. The procedure developed in this investigation provides a method by which the weights of certain elements can be determined with a relatively low radiation dose. (Diss. Abstr. Int., B)

38137 OPTIMUM TIME PROGRAMMING IN INSTRUMENTAL ACTIVATION ANALYSIS. Tyurnin, G. A.; Smakhtin, L. A. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 10, 1574-7(Oct 1971).

Translated from Zavod. Lab.; 37: No. 10, 1228-30(Oct 1971).

An expression is given for the mean-square-error of an instrumental activation analysis as a function of irradiation time (T^i), decay time (T^d), and measuring time (T^m). Conditional distribution densities are introduced and a time program can be derived in which the statistical error of determination reaches a specified value with a minimum loss of time. The condition of minimum time loss in the equation can be replaced by the requirement of minimum cost of analysis. A program for an M220 computer was written for finding the minimum of the relative mean-square-error of the determination as a function of T^i, T^d, and T^m. (B.L.M.)

38138 OXYGEN AND CARBON ASSAY OF METAL FOILS BY NUCLEAR REACTIONS. Kennedy, A. J.; Pacer, J. C.; Sprinzak, A.; Wiley, J.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Nucl. Instrum. Methods; 101: No. 3, 471-3(1972).

Oxygen and carbon impurities in metal foils have been assayed with a sensitivity of 2 to 25 ppM by measurement of proton energy spectra in reactions induced by 14-MeV protons. Energy spectra of α particles from (p,α) reactions have been used to distinguish between surface and body impurities. (auth)

38139 EVALUATION OF ERRORS CAUSED BY FLUX INHOMOGENEITIES IN THERMAL NEUTRON ACTIVATION ANALYSIS. Bruninx, E. (Philips Research Labs., Eindhoven, Netherlands). Anal. Chim. Acta; 60: No. 1, 207-17(Jun 1972).

Relative flux variations were measured in six pneumatic channels of a graphite-moderated reactor. Wires as well as solution detectors were used. The influence of these variations on the accuracy of activation analysis was estimated in one irradiation channel for a given combination of standards and samples. (auth)

38140 SIMULTANEOUS DETERMINATION OF LEAD, COPPER, AND ZINC IN SAMPLES OF POLYMETALLIC ORES AND PRODUCTS OF THEIR PROCESSING BY AN ACTIVATION METHOD. Navalikhin, L. V.; Kireev, V. A.; Talanin, Yu. N.; Nikonorov, G. S. This paper was summarized in At. Energ. (USSR); 30: No. 6, 535(Jun 1971) as paper No. 499/6016. (In Russian).

Full copy of this paper is held by TIC.

A rapid method of determining lead, copper, and zinc in samples of polymetallic ores using 14-MeV neutrons is described. The lead content is determined by measuring the induced activity of the isotope ^{207m}Pb. Cyclic irradiation of the samples and measurement of the induced activity are used. The value of the induced activity is measured with a rapid–slow coincidence spectrometer. The interfering influence of large contents of oxygen in the sample is considered simultaneously by measuring the activity of the isotope ^{16}N. The copper and zinc contents are determined according to the induced activity of the isotopes ^{62}Cu and ^{63}Zn, respectively. The measurements with a coincidence spectrometer are performed twice: the first 8 to 10 min after irradiation, the second after 35 to 10 min. Such a method permits combination of high output of the analyses with sufficient accuracy of the results obtained. An expression was obtained permitting selection of the optimum conditions of measurements of binary mixtures of radioisotopes, differing only in half-life, and an estimation of the measurement error. The calculated sensitivity of the determination of lead is 0.1%, and for copper and zinc (3 to 5) × 10^{-2}%. The mean square error of the determination does not exceed ±20% and depends on the content of the components to be analyzed. (auth)

38141 DETERMINATION OF HAFNIUM IN ORES AND PROCESSED PRODUCTS BY THE REACTION (γ,γ'). Kodiri, S. S.; Abrams, I. A.; Pelekis, L. L.; Starchik, L. P. At. Energ. (USSR); 32: No. 5, 428-30(May 1972). (In Russian).

A method of activation analysis of Hf by the (γ,γ') reaction is suggested which is rapid, selective, and highly sensitive. Inelastic scattering of γ quanta by ^{179}Hf nuclei leads to the metastable ^{179m}Hf. The excitation of ^{179m}Hf is produced by bremsstrahlung of a linear accelerator with 5-MeV electrons. In ores and derived products of Hf only Y offers interference in this method. (K.S.W.)

38142 NEUTRON ACTIVATION ANALYSIS OF AEGEAN OBSIDIANS. Aspinall, A. (Univ. of Bradford, Eng.); Feather, S. W.; Renfrew, C. Nature (London); 237: No. 5354, 333-4 (9 Jun 1972).

Neutron activation analysis has been employed to discriminate between the products of the various natural sources of obsidian in various parts of the world, and details of the technique as applied to fragments of mass 120 to 2700 mg are given. Irradiation was carried out in the Herald reactor at A.W.R.E., Aldermaston, England, for 48-hr periods at a thermal neutron flux density of 1.8×10^{12}n/cm^2/sec, and analysis was carried out using a Ge–Li crystal γ detector with associated amplifiers and a 1024-channel data accumulation system. Spectra were recorded on punched tape for computer processing. It was found that complete discrimination could be obtained using data for Cs, Ta, Rb, Th, Tb, Ce, and Fe, provided all concentrations were expressed relative to Sc. The latter was chosen as internal standard since it could be assessed with high accuracy for obsidians. Ways in which the analysis contributes to understanding of prehistoric trade in obsidians in the Aegean are stated. (UK)

38143 TRACE ELEMENT ANALYSES OF COLUMBIA RIVER WATER AND PHYTOPLANKTON. Cushing, C. E.; Rancitelli, L. A. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Northwest Sci.; 46: No. 2, 115-21(May 1972).

Water and phytoplankton samples collected upstream from the Hanford Atomic Works Project were analyzed by neutron activation. Data obtained were compared with those from samples submitted to a routine analytical laboratory. Elements determined include: Ag, As, Au, Br, Co, Cr, Cs, Cu, Fe, Hg, K, Mn, Na, Rb, Sb, Sc, Se, U, Zn. (M.C.G.)

38144 MATCHING OF STOLEN TELEPHONE WIRE BY ACTIVATION ANALYSIS OF THE TRACE ELEMENT COMPOSITION. Weaver, Jack N.; Bowman, Worth B. (North Carolina State Univ., Raleigh). J. Forensic Sci.; 16: No. 4, 521-9(Oct 1971).

The successful use of activation analysis as an analytical tool for determining the trace composition of copper telephone wire samples for the purpose of matching those of common origin is described. The trace elements determined are antimony, cobalt, silver, and tin. (auth)

38145 DETERMINATION OF BODY COMPOSITION BY NEUTRON ACTIVATION ANALYSIS IN PATIENT WITH RENAL FAILURE. Cohn, Stanton H.; Cinque, Thomas J.; Dombrowski, Carl S.; Letteri, Joseph M. (Brookhaven National Lab., Upton, N. Y. Nassau County Medical Center, East Meadow, N. Y.). J. Lab. Clin. Med.; 79: No. 6, 978-94(Jun 1972).

In vivo neutron activation analysis and whole-body counting techniques were used to measure the body composition of patients with chronic renal failure. Levels of total-body calcium, phosphorus, sodium, chlorine, nitrogen, and potassium were measured in uremic patients at various times prior to and during maintenance dialysis. The TBNAA technique requires that a uniform irradiation of the whole body be made with moderated fast neutrons. The primary thermal neutron reactions occurring are $^{48}Ca(n,\gamma)^{49}Ca$, $Na(n,\gamma)^{24}Na$, and $^{37}Cl(n,\gamma)^{38}Cl$. Simultaneously, the following fast neutron reactions occur: $^{14}N(n,2n)^{13}N$ and $^{31}P(n,\alpha)^{28}Al$. The radiation from these induced activities is measured by whole-body counting techniques. (D.H.M.)

38146 ACTIVATION ANALYSIS OF AIR BORNE DUST. Mamuro, Tetsuo; Matsud, Yatsuka; Mizohata, Akira; Matsunami, Tadao. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 1-9(1971).

Instrumental neutron activation analysis by γ spectrometry with a high-resolution and large-volume Ge(Li) detector followed by data analysis with an electronic computer was applied to elemental analysis of airborne dust samples that were collected at four stations selected in Osaka and Sakai cities. Monthly concentrations of various elements were determined during the period from March 1970 through March 1971. For most elements the highest concentration appeared in November to December and the lowest in August. A somewhat lower peak concentration appeared around June. Such a seasonal variation is considered to be ascribed mainly to the meteorological conditions in Osaka district. Conspicuous area dependency was found, especially for concentrations of Se, Hf, As, Ba, La and Th. The main pollution source of Br is possibly the gas discharged from automobiles. Correlation coefficients between the concentrations of various elements were calculated. (auth)

38147 IDENTIFICATION OF AN AIR POLLUTION SOURCE BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Mamuro, Tetsou; Matsuda, Yatsuka; Mizohata, Akira. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 10-12(1971).

Instrumental neutron activation analysis by the use of γ spectrometry with a large-volume and high-resolution Ge(Li) detector followed by automatic data analysis by an electronic computer is an effective means of identifying pollution materials or their sources, because it allows to make multi-element analysis simplifying or abbreviating troublesome chemical separation procedures. An attempt was made to apply this technique to identification of some hazardous material that caused skin disease and was believed to be contained in the smoke being discharged from a stack of a factory. Airborne dust was collected at four sampling points around the factory and concentrations of 26 elements were determined. By comparing the concentrations of various elements measured at the four sampling points with one another and with those measured at other two stations distant from there at nearly the same time, the hazardous material in question was concluded to be Se compounds. It was also confirmed that besides Se, the stack released noticeably Ni, As, Ag, and Ce, and slightly Sc, Rb, La, Sm, Lu, and Th. (auth)

38148 NONDESTRUCTIVE DETERMINATION OF HAFNIUM IN ZIRCONIUM BY Be–D NEUTRON ACTIVATION ANALYSIS USING SELENIUM AS INTERNAL STANDARD. Jinno, Kiyokatsu; Katayama, Kozo; Ishii, Daido (Nagoya Univ., Japan). Nippon Kagaku Kaishi; 1972: No. 1, 78-81(Jan 1972). (In Japanese).

A rapid and nondestructive method is required for the determination of hafnium content in zirconium. A fast neutron activation method based on the measurement of the short half-life isotope ^{179m}Hf produced by the $^{179}Hf(n,n')^{179m}Hf$ reaction was investigated. The use of Be–D neutrons has made it possible to avoid the interferences from oxygen, zirconium, and other elements. Selenium was used as an internal standard material for assuring the precision of the analytical results. (Japan)

38149 POSSIBILITIES IN METALLURGY FOR ACTIVATION ANALYSIS WITH 14 MeV NEUTRONS. Vorsatz, Bruno; Szarka, Gyula. Neue Huette; 17: No. 1, 34-9(Jan 1972). (In German).

Activation analysis with neutron generators offers excellent possibilities for determination of various elements. For numerous other elements, simple analytical procedures can be established. Nuclear reactions leading to isotopes with short half-lives permit rapid determinations such as that of oxygen within 30 to 60 seconds. Moreover, activation analysis allows serial analysis of large numbers of samples. Determinations frequently are simple and can be performed automatically. Comparison of installation cost with that of the analytical performance shows that, in most cases, the facility pays for itself within a brief period of operation. (tr-auth)

38150 ANALYSIS OF HIGH PURITY TIN BY MEANS OF NEUTRON ACTIVATION. Lanfranco, G. (Centro Ricerche Metallurgiche SpA, Turin). Met. Ital.; 63: No. 5, 225-32(May 1971). (In Italian).

A method is described for determining impurities in high-purity tin by means of neutron activation and radiochemical separations. In order to make analyses easier, impurities were divided into three groups, namely: (I) Au, Ag, Ge, Co, Ni, Cu, Zn; (II) Fe, Ga, Tl, As, Hg; (III) Cd, In, Sb. The elements of groups I and II are determined after irradiation in a flow of 3×10^{13} thermal neutrons/cm^2 · sec, containing a high ratio of fast neutrons. The elements of group III are determined after irradiation in a flow of 5×10^{12} thermal neutrons/cm^2 · sec, thermal neutron/fast neutron ratio being kept = 1000, in order to reduce effects of interfering reactions. The samples are dissolved in the presence of "carriers" of the elements to be determined, the latter being separated from the matrix, purified, and eventually precipitated in the form of the well-defined chemical compounds, in order to determine the chemical yield of the separation. Gamma radioactivity measurements are made by means of a multichannel pulse-height analyzer, whereas measurements of radionuclides emitting pure beta rays (^{210}Bi) or x rays (^{71}Ge) are made with a Geiger–Müller counter. Quantitative data can be obtained by comparing measured activity with that of a known amount of the element to be determined, contained in a reference tin alloy irradiated together with the samples. The results of some analyses are given. (auth)

38151 BODY ACTIVATION ANALYSIS: A SUBSTITUTE FOR GI ABSORPTION AND EXCRETION STUDIES. Nelp, Wil B. (Univ. of Washington, Seattle). Contract AT(45-1)-2225. pp 310-19 of Hematopoietic and Gastrointestinal Investigations with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1972).

From Hematopoietic and gastrointestinal investigations with radionuclides conference; Miami, Fla. (3 Mar 1971).

Total body neutron activation analysis is a unique tool in nuclear medicine which can be developed for practical application in patient studies. It is a very suitable substitute for certain GI absorption and excretion balance studies, particularly for extended periods of time. With the future development of portable or semiportable 14-MeV neutron generators of high flux it is anticipated that such balance studies can be carried out with good precision and reproducibility at many medical centers. (auth)

38152 NEUTRON-ACTIVATION DETERMINATION OF URANIUM AND SAMARIUM IN CAMBRIAN CARBONIC SHALES. Kalmurzaev, K. E.; Balbakov, Dzh.; Shakirov, Eh. Sh.; Yankovskii, A. V. Izv. Akad. Nauk Kirg. SSR; No. 6, 24-7(Nov 1971). (In Russian).

A method is described for the simultaneous determination of U and Sm in rocks without prior chemical decomposition of the sample. The neutron activation technique described was first used for carbonaceous Cambrian schist. The sensitivity of the determination is 10^{-6} to 10^{-8} g, and its accuracy is 10%. (tr-auth)

Chemical and Spectral Procedures

Refer also to abstracts 38965 and 40229.

38153 (HEDL–TME–71–17) MOCK-UP TESTING OF RADIOACTIVE SODIUM ANALYSIS METHODS AND EQUIPMENT. Lust, L. F.; Scott, F. A.; Jarosch, J. F. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1971. Contract AT-(45-1)-2170. 51p. Dep. NTIS.

A mock-up facility with two stations operated by master-slave manipulators, one with an air atmosphere and the other with a pure argon atmosphere, was constructed and used to evaluate procedures and equipment for the remote analysis of highly radioactive sodium coolant from the FFTF. The argon in the inert-atmosphere cell was maintained with less than 1 ppM each of oxygen and water. Procedures for determination of traces of oxygen, hydrogen, and carbon were easily adapted to remote operation. The procedure for the remote determination of oxygen by amalgamation was evaluated in the mock-up facility with sodium metal samples. Blanks, precision, and accuracy were as good as those normally obtained in glove-box operation. (auth)

38154 (HEDL-TME-72-56) COMPARISON OF THERMOGRAVIMETRIC METHODS USED TO DETERMINE OXYGEN-TO-METAL RATIOS IN MIXED OXIDE FUELS. Urie, M. W.; Burt, M. C.; Delvin, W. L. (Hanford Engineering Development Lab., Richland, Wash.). Apr 1972. Contract AT(45-1)-2170. 14p. Dep. NTIS.

A comparison of three thermogravimetric methods shows that the respective oxygen-to-metal ratios obtained are equivalent to within 0.003 O/M units. This equivalence was demonstrated using sintered $(U_{0.75}-Pu_{0.25})O_{2-x}$ pellets. (auth)

38155 (KAPL-P-3942) EFFECTS OF CHEMICAL PROCESSING ON THE THERMAL IONIZATION EFFICIENCY OF PLUTONIUM. Rourke, Francis M.; Mewherter, Jack L. (Knolls Atomic Power Lab., Schenectady, N. Y.). 1972. 5p. (CONF-720607-11). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

Isotopic analysis of dilute aqueous samples of pure plutonium nitrate even at the 10^{-16} g level run successfully on the KAPL three-stage mass spectrometer, and reproducibly yield 4×10^6 detected ions per picogram of plutonium mounted. On the other hand, extensive chemical processing to recover even larger amounts of trace plutonium from various matrices invariably produces at least an order of magnitude poorer efficiency for plutonium ion detection. (auth)

38156 (LFEN-128-a) POLAROGRAPHIC DETERMINATION OF URANYL FLUORIDE IN URANIUM TETRAFLUORIDE. Silva, A. Jr. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1971. 32p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A comparative study was made of the polarographic determination of uranyl fluoride in perchloric and phosphoric acid medium and in media using sulfuric acid or sulfuric and boric acids. The advantages and inconveniences of using each of these media are determined. The parameters that can affect the polarographic determination are studied. (J.S.R.)

38157 (NIM-1408) DETERMINATION OF MOLYBDENUM IN THE SOLIDS AND SOLUTIONS RESULTING FROM THE PROCESSING OF WITWATERSRAND URANIUM ORES. Laboratory Method No. 42/4. Cook, E. B. T.; Silverthorne, D. F. (National Inst. for Metallurgy, Johannesburg (South Africa)). 15 Mar 1972. 7p. Dep. NTIS (U. S. Sales Only).

A method for the determination of molybdenum in solids (after a dissolution step) and solutions containing uranium and organic matter is described. Molybdenum is extracted, as the dithiol complex, from 6.2M hydrochloric acid into petroleum ether and determined by a previously published spectrophotometric procedure. Iron, manganese, and elements commonly associated with the dissolution of uranium in Witwatersrand ores do not interfere. Arsenic and antimony, which interfere in the spectrophotometric step, are volatilized by a special procedure. Copper and tungsten should not exceed 1 and 2 mg, respectively, in the aliquot portion taken for extraction. The method is intended for the determination of molybdenum in concentrations of from 0.05 to 80 ppm in solutions having a U_3O_8 concentration of not higher than 20 g/l. (auth)

38158 QUALITATIVE CHEMICAL ANALYSIS WITH THE HEXACYANOCHROMATE(III) ION. Vicente-Perez, S.; Perez-Perez, R.; Medina-Escriche, J. (CSIC, Madrid). Inform. Quim. Anal., Pura Apl. Ind.; 24: No. 5, 154-63(1970). (In Spanish).

The reactions of various cations with 0.5 M $K_3Cr(CN)_6$ were examined. Precipitates were obtained with Ag, Pb(II), Hg(I), Hg(II), Cu(II), Cd, Pd(II), Fe(II), U(VI), Ni, Co(II), Mn(II), and Zn. The reaction with Pd(II) was the most sensitive (pD = 4.7), but most of the other species that react with $Cr(CN)_6^{3-}$ interfere or reduce the sensitivity. (Anal. Abstr.)

38159 PHOTOMETRIC DETERMINATION OF MOLYBDENUM IN STEELS AND ALLOYS BASED ON NICKEL IN THE FORM OF A MOLYBDENUM-UNITHIOL COMPLEX. Novak, V. P.; Bogovina, V. I.; Bedovik, S. S.; Mal'tsev, V. F. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 10, 1495-6(Oct 1971).

Translated from Zavod. Lab.; 37: No. 10, 1170-1(Oct 1971).

A photometric method for the determination of Mo in steels and Ni-base alloys without extraction was developed using the unithiol complex of Mo(V) or Mo(VI). Optimum conditions for complex formation was 0.2 to 0.5N HCl solution with maximum color development after 5 min. The absorption maximum occurs at 345 nm, and the system conforms to Beer's law up to 0.8 mg Mo/50 ml. Only Fe(II) and Cu(II) interfere. The determination takes ~30 min, and the relative error is 3%. (B.L.M.)

38160 DETERMINATION OF PLUTONIUM BY TWO-STEP FLOW-COULOMETRY AT THE COLUMN ELECTRODE. Kihara, Sorin (Japan Atomic Energy Research Inst., Tokai); Yamamoto, Tadashi; Motojima, Kenji; Fujinaga, Taitiro. Talanta; 19: No. 5, 657-68(May 1972).

A two-step flow-coulometry method was developed for rapid determination of elements that exist in various oxidation states in solution and applied to the determination of plutonium in 0.5M sulphuric acid medium. The first-step column electrode potential is fixed at between +0.10 and +0.35 V vs Ag-AgCl, and all plutonium ions are reduced to Pu(III). The second-step column electrode potential is fixed at +0.75 V vs Ag-AgCl, and Pu(III), which flows from the first column electrode, is oxidized to Pu(IV). The quantity of plutonium is determined from the number of coulombs used in the oxidation. It is possible to eliminate interference by diverse ions by electroanalysis at the first column electrode. About a 10-μl sample is necessary and the electrolysis is finished in about 1 min. (auth)

38161 ANALYTICAL CHEMISTRY OF SCANDIUM. Mullin, Michael David. Detroit; Wayne State Univ. (1971). 65p. University Microfilms Order No. 72-14,604.

Thesis.

The use of benzilic acid as a quantitative precipitant for the determination of Sc was studied. The metal forms a 1:3 compound with benzilic acid. The effect of pH on the precipitate was determined. The range of analytical utility was from pH 2.0 to 4.0. Quantities of scandium equivalent to 2 to 105 mg of scandium oxide were determined. The determination of Sc in the presence of Zr using benzilic acid was studied. Zr was precipitated first with benzilic acid in 2 N hydrochloric acid and the filtrate adjusted to pH = 2.5 to precipitate the Sc. With approximately equal quantities of Sc and Zr, the separation was quantitative. A radiochemical study of Sc was undertaken. The efficiency of separation of Sc from Zr using benzilic acid was determined using ^{46}Sc as a radioactive tracer. The separation was quantitative when approximately equal quantities of Sc and Zr were determined. The solubility of scandium benzilate also was determined with the aid of ^{46}Sc and was found to be 8.4×10^{-6} moles/liter of scandium benzilate. A study was made of the Sc complex of rufigallic acid to determine the usefulness in determining Sc. The metal forms a 1:3 complex with rufigallic acid with a maximum absorbance at 555 nm. The effect of pH on the complex was determined. Optimum color development was obtained in a pH range from 4 to 6. The effect of heating and time of standing were determined for the complex. The complex conforms to Beer's Law over the range of 0.20 to 2.25 μg/ml of Sc. The optimum concentration range is from 0.32 to 0.99 μg/ml of Sc as determined from a Ringbom plot. The molar absorptivity for the Sc-rufigallic acid complex is approximately 6500 liter/mole-cm. The complex was found to be stable for approximately two hr. The determination of Sc in the presence of Zr using rufigallic acid was studied. Sc can be determined in the concentration range of 0.20 μg/ml of Sc in the presence of 0.7 to 3.5 μg/ml of Zr with a relative standard deviation of less than ± 5%. (Diss. Abstr. Int., B)

38162 LASER EXCITED ATOMIC FLUORESCENCE. Fraser, Llewellyn Michael. Gainesville, Fla.; Univ. of Florida (1971). 159p. University Microfilms Order No. 72-15,675.

Thesis.

Laser-excited atomic fluorescence is shown to have advantages over conventional atomic fluorescence. An instrumental system using a pulsed tunable dye laser as a source is described. The theoretical improvement in signal-to-noise ratio from using a pulsed source-pulsed detector system is derived. Experimental results presented indicate the validity of the theory. Analytical curves and limits of detection are presented for thirteen elements: Al, Ca, Cr, Co, Fe, Ga, In, Mn, Mo, Ni, Sr, Ti, and Tl. In addition to resonance fluorescence, analytical curves for thermally assisted resonance, direct line, thermally assisted direct line, and excited direct line fluorescence are presented; the analytical curves agree with those predicted by theoretical equations describing such transitions. (Diss. Abstr. Int., B)

38163 SPECTROPHOTOMETRIC DETERMINATION OF UO_2^{2+} IONS WITH HESPERETIN. Korkuc, Anna (Lodz Academy of Medicine, Poland). Acta Pol. Pharm.; 28: No. 5, 575-7 (1971). (In Polish).

UO_2^{2+} ions form a yellow-colored complex in a solution of hesperetin (3',5,7-hydroxy-4'-methoxyflavanone). This reaction was used to detect small amounts of UO_2^{2+}. It was found that the limit of detection lies at 2.8 $\mu g/cm^3$. The absorption was determined as a function of the wavelength of the light source, the pH of the solution, and time. The most favorable wavelength range for analytical purposes was found to lie between 3750 and 4100 Å; the best pH range was between 6 and 8. No time dependence could be established for a period up to 6 hours. The effect of various impurities was also examined. The method was found to be sensitive and to yield accurate results. (TTT)

38164 VOLATILE ALKALINE EARTH CHELATES OF FLUORINATED ALKANOYLPIVALYLMETHANES. A THERMOGRAVIMETRIC, GAS CHROMATOGRAPHIC, AND MASS SPECTRAL STUDY. Belcher, R.; Cranley, C. R.; Majer, J. R.; Stephen, W. I.; Uden, P. C. (Univ. of Birmingham, Eng.). Anal. Chim. Acta; 60: No. 1, 109-16(Jun 1972).

The synthetic details and characterization of some alkaline earth chelates of fluorinated alkanoylpivalylmethanes are given. The mass spectra of the calcium, strontium, and barium compounds exhibit peaks due to polymeric ions, and some fragmentation steps of these ions are postulated. The thermogravimetric properties of hydrated and dehydrated chelates are described in terms of relative volatility and stability. The results of a preliminary gas chromatographic study are discussed; elution appears to occur without decomposition but no separation of the calcium, strontium, and barium chelates is achieved. (auth)

38165 FRACTIONAL SUBLIMATION OF VARIOUS METAL CHELATES OF DIPIVALOYLMETHANE. Berg, Eugene W.; Herrera, Nicolas M. (Louisiana State Univ., Baton Rouge). Anal. Chim. Acta; 60: No. 1, 117-25(Jun 1972).

Twenty different metal chelates of dipivaloylmethane were prepared and characterized by melting points, carbon—hydrogen analyses, and infrared and NMR absorption data. The pure chelates were sublimed in the Berg fractional vacuum sublimator and the temperature condensation (sublimation) zones were recorded for each chelate under standardized conditions. The beryllium(II) chelate was the most volatile and the lanthanide and actinide chelates among the least volatile dipivaloylmethanates. The only volatile alkaline earth metal chelates were those of Be(II) and Mg(II); the Ca(II), Sr(II), and Ba(II) chelates were not volatile under the conditions used. Overall it was found that the chelates of dipivaloylmethane exhibited volatilities similar to those of the corresponding metal acetylacetonates but less than those of the trifluoroacetylacetonates and the hexafluoroacetylacetonates. The chelates of benzoylacetone, benzoyltrifluoroacetone, and thenoyltrifluoroacetone are less volatile than the corresponding chelates of dipivaloylmethane. The data suggest that some 64 different binary and ternary mixtures of metal dipivaloylmethane chelates can be quantitatively resolved. Seven binary and three ternary mixtures of the metal chelates were resolved satisfactorily. (auth)

38166 COULOMETRIC TITRATION WITH +3 URANIUM. APPLICATION TO THE DETERMINATION OF URANIUM. Farrington, Gregory C.; Lingane, James J. (Harvard Univ., Cambridge, Mass.). Anal. Chim. Acta; 60: No. 1, 175-82(Jun 1972).

The most powerful reductimetric titrant used to date; +3 uranium, was generated in acidic solution with nearly 100% current efficiency, and applied to the constant-current coulometric titration of +6 uranium. The titration error is +0.09% with a 211-mg uranium sample. The potentiometric titration curve for the titration of +6 uranium with +3 uranium has shown that the UO_2^{2+}/UO_2^{+} couple is potential-determining in mixtures of +6, +5, and +4 uranium. A brief review of the literature dealing with the standard potential of the UO_2^{2+}/U^{4+} and the UO_2^{+}/U^{4+} couples at 25°C is presented. It was concluded that the values are +0.246 V and +0.429 V vs N.H.E., respectively, instead of +0.334 V and +0.62 V vs N.H.E. as previously accepted. The standard free energies of U^{3+} and U^{4+} are −120.4 and −134.4 kcal $mole^{-1}$, respectively, at 25°C. (auth)

38167 SOLVENT EXTRACTION SEPARATIONS WITH BATHOPHENANTHROLINE. APPLICATIONS TO THE MICROANALYSIS OF ELEMENTS IN URANIUM BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Sparks, R. W.; Vita, O. A.; Walker, C. R. (Goodyear Atomic Corp., Piketon, Ohio). Anal. Chim. Acta; 60: No. 1, 222-5(Jun 1972).

A solvent extraction system based on bathophenanthroline increased the sensitivity of the atomic absorption spectrophotometric method for determination of Cu, Fe, and Ni in uranium. (M.C.G.)

38168 IMPROVED SEPARATION AND DETERMINATION OF URANIUM IN SEAWATER. Leung, Gregory; Kim, Young S.; Zeitlin, Harry (Univ. of Hawaii, Honolulu). Anal. Chim. Acta; 60: No. 1, 229-32(Jun 1972).

The use of thorium hydroxide coupled with measurement of fluorescence intensity of the uranium—Rhodamine B complex for separation and determination of uranium in seawater by the adsorbing colloid flotation technique was studied. Use of sodium dodecanoate as anionic surfactant improved the recovery of uranium. (M.C.G.)

38169 DISSOLUTION OF HIGH-FIRED PLUTONIUM OXIDE FOR THE DETERMINATION OF PLUTONIUM. Angeletti, L. M.; Bartscher, W. J. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Anal. Chim. Acta; 60: No. 1, 238-41(Jun 1972).

The application of different acid sulfate fluxes to the dissolution of samples in routine analysis was investigated to establish a standard dissolution procedure for either pure plutonium oxide or oxide mixtures containing high-fired plutonium oxide. Fusion with a mixture of sodium pyrosulfate or potassium pyrosulfate was preferable to treatment with one of these salts alone. (M.C.G.)

38170 DETERMINATION OF SMALL AMOUNT OF RARE EARTH ELEMENTS AND NON-RARE EARTH ELEMENTS IN YTTRIUM OXIDE BY EMISSION SPECTROGRAPHIC METHOD. Sato, Matsuji (Shinetsu Chemical Industry Co. Ltd., Takefu, Japan). Bunseki Kiki; 9: No. 12, 780-7(Dec 1971). (In Japanese).

By use of a controller of surrounding gases, determination limits for cerium, praseodymium, neodymium, and terbium were largely decreased. A mixture of argon and oxygen (4 : 1) is used to suppress background and to eliminate CN bands. Thus spectrum lines of sufficient intensity were obtained for determination of the above elements. The determination was made also without any correction for residues of rare earth and non-rare earth impurities by the use of yttrium oxide, which was purified by ion-exchange separation and homogeneous precipitation. It was found that superposition of a weak line with an analytical line of dysprosium, Dy 3407.80 Å, was not due to yttrium as reported in the literature, but was due to an unidentified material, presumably the CN band. When the calcination temperature for samples was low, weight increase was remarkable when they were kept in the natural atmosphere. It was necessary to calcine the samples above 900°C, and keep them in a desiccator to prevent adsorption of carbon dioxide and moisture to obtain sufficient accuracy. (Japan)

38171 IMPURITY DETERMINATION IN GROUP III—V COMPOUNDS. Wang, M. S. (Monsanto Co., St. Louis). Appl. Spectrosc.; 26: No. 3, 364-9(May-Jun 1972).

Methods for determination of trace and ultratrace impurities (including Mo, Sr, Co) in group III—V compounds by emission spectroscopy were investigated. Cleaning of organic and inorganic surface contaminants must be carefully carried out so that ultratrace determination is possible. The method takes advantage of preferential volatilization of group III—V compounds in a dc arc. Sequential exposure is used to improve signal-to-noise ratio. Concentrating the impurities in the electrode by arcing off some of the arsenic in gallium arsenide improves detection limits of relatively nonvolatile elements. The analytical results agree well with other techniques. Electrical properties of compounds also correlate well with the data. The coefficients of variation range from 20 to 40%. (auth)

38172 DETERMINATION OF MICRO-AMOUNTS OF URANIUM AND THORIUM IN MAGMATIC ROCKS. Udal'tsova, N. I. Izv. Sib. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk; No. 3, 127-9(May 1971). (In Russian).

A method for determination of micro-amounts of uranium and thorium (1×10^{-4} to 1×10^{-5}%) in rocks and minerals from one weighing is described. (auth)

38173 ELECTROCHROMATOGRAPHY OF RARE ELEMENTS. II. SEPARATION OF RHENIUM(VII), MOLYBDENUM(VI), VANADIUM(V), AND TUNGSTEN(VI) IN A SULFURIC ACID MEDIUM ON A LAYER OF ALUMINUM OXIDE. Gaibakyan, D. S.; Sagradyan, S. I. (Erevan State Univ.). Arm. Khim. Zh.; 24: No. 8, 668-72 (1971). (In Russian).

The separation and determination of microgram quantities of Re, Mo, V, and W was accomplished by electrochromatography on thin layers (0.1 mm) of Al_2O_3, using a 0.1N H_2SO_4 solution as electrolyte. Under the conditions 400 V and 1 to 3 mA for 30 min duration, the ions ReO_4^-, MoO_4^{2-}, VO_3^-, and WO_4^{2-} were quantitatively separated. Two spots of Mo(VI) were obtained from 0.5N H_2SO_4. (tr-auth)

38174 COMPLEX COMPOUNDS OF MOLYBDENUM(VI) WITH d-GLUCONIC ACID. Fedorov. A. A.; Pavlinova, A. V. (Chernovtsy State Univ., USSR). Zh. Anal. Khim.; 27: No. 4, 708-12(Apr 1972). (In Russian).

Complex formation between Mo(VI) and d-gluconic acid proceeds with the participation of the hydroxy and carbonyl groups of gluconic acid. The complex anions $(HMoO_3)_2GH_2^{--}$ and $HMoO_3GH_3^-$ are formed in an acid medium. The complex-forming form of Mo(VI) is H_2MoO_4 at pH < 4.0 and $HMoO_4^-$ at pH > 4.0. The instability constant of the 2 : 1 complex compound is of the order of $(7.6 \pm 1.3) \cdot 10^{-8}$. It is suggested that d-gluconic acid is suitable for use for the polarimetric determination of molybdenum at pH 3.5. (auth)

38175 INTERACTION OF THE THIOCYANATE COMPLEX OF MOLYBDENUM WITH CRYSTAL VIOLET. Ganago, L. I.; Ivanova, I. F. (Inst. of Physics of Solids and Semiconductors, Minsk). Zh. Anal. Khim.; 27: No. 4, 713-18(Apr 1972). (In Russian).

Conditions were studied for the reaction of the thiocyanate complex of molybdenum with Crystal Violet, and the possibility of its isolation was found. The optimum concentration ratio of molybdenum : thiocyanite : Crystal Violet = 1 : 5 : 2 was found by the methods of equilibrium shift and isomolar series. The composition of the complex was confirmed by the analysis of the precipitate. A method for the extraction—photometric determination of microamounts of molybdenum was developed. (auth)

38176 LUMINESCENCE METHOD OF DETERMINING RARE EARTH ELEMENTS IN GEOCHEMICAL SAMPLES. Anikina, L. I.; Balashov, Yu. A.; Vul'fson, E. K.; Karyakin, A. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 27: No. 4, 787-9(Apr 1972). (In Russian).

A luminescence method was developed for determining gadolinium and europium in natural samples. The method includes the preliminary isolation of the sum of rare earth elements and the preparation of crystallophosphors (based on yttrium oxide in case of determining gadolinium and on yttrium vanadate in case of determining europium) from the concentrate isolated. The sensitivities of determining gadolinium and europium are 10^{-6} and 10^{-5}%, respectively. (auth)

38177 CHEMICAL-SPECTRAL DETERMINATION OF RARE EARTH ELEMENTS IN SOLUTIONS CONTAINING TITANIUM, ZIRCONIUM, LEAD, AND BARIUM. Karpenko, L. I.; Fadeeva, L. A. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 27: No. 4, 789-93(Apr 1972). (In Russian).

Effects of Ti, Zr, and Pb on the relative intensity of the spectral lines of the rare earth elements were studied for spark analysis of solutions that are introduced into a source by means of a combination porous electrode. Ti, Zr, and Pb equally affect the excitation of the spectra of rare earths of the cerium and yttrium subgroups. The method appears suitable for the analysis of solutions of different chemical composition and variable concentration of the solute; separate rare earths can be determined. A chemical—spectral method was suggested for determining La, Nd, and Eu in substances containing Ti, Zr, Pb, and Ba as main components. The sensitivity of the determination of rare earths is 0.01 to 0.08 mg/ml (of oxides); the variation coefficient is 8 to 10%. (auth)

38178 SAMPLER FOR SPECTROGRAPHIC ANALYSES. Raiteri, E. (Fiat LRCAA, Turin). Met. Ital.; 63: No. 5, 239-42(May 1971). (In Italian).

To prevent the need for transporting heaving materials, a sampler was devised that permits the transfer into electrodes of small amounts (ca. 10 mg) of the material of large-size metal components. The samples so obtained are then analyzed spectrographically. It is thus possible to assess the composition of steel and Al-, Ni-, Ti-base alloys. (auth)

38179 FISSION TRACK ANALYSIS OF URANIUM IN MANGANESE NODULES COLLECTED FROM THE PACIFIC OCEAN FLOOR. Yabuki, Hideo (Inst. of Physical and Chemical Research, Wako, Japan). Sci. Pap. Inst. Phys. Chem. Res. (Jap.); 65: No. 3-4, 100-4(Dec 1971).

Fission track determination of uranium in eight manganese nodules collected from the Pacific Ocean floor is reported. For induced fission track analysis, the method of internal standard addition was applied in which a uranium solution of known concentration was mixed with powdered samples. Five different amounts of uranium added samples were made for individual nodules, and each of them was filled in a hole in a plastic plate, both sides of which were covered with polycarbonate sheets. These were irradiated in a reactor, and then chemical etching was applied to the polycarbonate detectors. As expected, the relation between added uranium and the density of etch pits is linear, and extrapolation of the curve to zero track density makes it possible to carry out a much simplified determination of natural uranium content. Furthermore, the factors of error are much decreased in this analysis by the elimination of complex calculations and several assumptions. The results obtained were in the range of 6 to 14 ppM for uranium. For the sake of comparison, this method was applied to the K-1 sample and the result was in good agreement with spectrometric data. (Japan)

38180 SPECTROCHEMICAL DETERMINATION OF GALLIUM, INDIUM, AND THALLIUM TRACES BY USE OF AN EXTRACTION SYSTEM WITH THREE FLUID PHASES. Busev, A. I.; Zhivopistsev, V. P.; Petrov, B. I.; Degtev, M. I. (Moscow State Univ. Perm State Univ., USSR). Anal. Lett.; 5: No. 5, 265-72(1972). (In German).

A new method for concentrating microgram amounts of elements before their spectral determination is described. The method is based on the property of diantipyrilmethane to divide the organic solvent into two phases, i.e., during the extraction of elements the three liquid phase system is formed. In one of the phases (the "third phase") 93 to 98% of the extractable elements are concentrated. Owing to the small volume the third phase may be dropped onto electrodes avoiding evaporating, ashing of extracts, and filling of electrodes before spectral determination. This reduces the duration of analysis by a half or a third and increases the accuracy and sensibility of determinations. Based on the three liquid phase system a spectrochemical method was developed for microgram amounts of Ga, In and Tl(III) in Mg, Be, Al, Sc, Y, La, Ce, Zn, Cd, and Pb. The use of such systems in analytical chemistry would be perspective. (auth)

38181 USE OF L-ASCORBIC ACID IN THE POTENTIOMETRIC DETERMINATION OF Ce(IV). Baczyk, Stefan; Karlik, Bogdan (Inst. of Chemistry and Analysis, Poznan, Poland). Chem. Anal. (Warsaw); 17: No. 2, 311-16(1972). (In Polish).

A method for direct determination of Ce(IV) in the solutions of pure salts and in the presence of several other cations is presented. The method consists of potentiometric titration of ceric ions with 0.01N L-ascorbic acid solution. Best results were obtained in 5N H_2SO_4 medium. The reaction is quite fast. End point detection was sharp and the results reproducible and consistent with those obtained with the ferrometric method, which was used for comparison. Ce(IV) ions can be determined in the presence of Zn(II), Mg(II), Cu(II), Ni(II), Fe(III), and Al(III) ions which interfere when present in a concentration at least twice as high as that of Ce(IV). (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 38412 and 38442.

38182 (AERE-R—6700) DETECTION OF HYDROGEN IN CELLULOSE ACETATE BY NEUTRON RADIOGRAPHY. Matfield, R. S. (Atomic Energy Research Establishment, Harwell (England)). Apr 1972. 14p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Thermal-neutron techniques are particularly suited to the detection of hydrogen since the hydrogen atom has a much larger neutron attenuation cross section for neutrons of this energy than most other elements. Neutron radiography has some advantages over other neutron methods as it provides a pictorial record, i.e., a radiograph of the hydrogen distribution in a sample. This distribution is recorded as variations in photographic film density, which can be analyzed to give quantitative results. Application to cellulose acetate is described. (auth)

38183 (BNWL—1183-11) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, January 3, 1972—April 2, 1972. Brodzinski, R. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 15 Apr 1972. Contract AT(45-1)-1830. 29p. Dep. NTIS.

Results are reported on the analysis of fecal specimens of the Apollo 15 astronauts and measurement of radon-222 activity in the lunar atmosphere and on the surface at Oceanus Procellarum. Only two of the fecal specimens collected inflight during the Apollo 15 mission were returned for analysis. Difficulty in obtaining reasonably accurate radiation dose estimates based on the cosmogenic radionuclide content of the specimens was encountered due to the limited sampling. The concentrations of ^{22}Na, ^{40}K, ^{51}Cr, ^{59}Fe, and ^{137}Cs are reported. The concentrations of 24 major, minor, and trace elements in these two specimens were determined by neutron activation analysis. Most concentrations are typical of those observed previously. Major exceptions are extremely low values for selenium and extraordinarily high values for rare earth elements. The net ^{210}Po activities in the Apollo 11 and 12 Solar Wind Composition foils and in the Apollo 8 and 12 spacecraft reflective coatings due to lunar exposure were determined. Equilibrium concentrations of 0.082 ± 0.012 disintegrations cm^{-2} sec^{-1} of ^{222}Rn in the lunar atmosphere and 0.0238 ± 0.0035 disintegrations cm^{-2} sec^{-1} of ^{210}Po on the lunar surface were calculated for Oceanus Procellarum. (auth)

38184 ION EXCHANGER RADIOMETRIC TITRATIONS. Toelgyessy, Juraj; Konecny, Jiri (Chemickotechnologicka Fakulta, Bratislava). Chem. Listy; 66: No. 4, 337-71(1972). (In Slovak).

The principles, theoretical and experimental bases, as well as characteristic examples of the utilization of ion exchange resins for separation of the products of titration from the starting components during radiometric titrations (ion exchanger radiometric titrations are described. These titrations enable a wider use of radioactive nuclides in volumetry and they promise wide perspectives for the determination of submicrogram amounts of substances. The sensitiveness of these titrations exceeds in some cases that of activation analysis. (auth)

38185 GAS CHROMATOGRAPHIC SEPARATION AND QUANTITATIVE DETERMINATION OF THE SIX ISOTOPIC HYDROGEN MOLECULES. van Urk, P.; Lindner, L. (Instituut voor Kemphysisch Onderzoek, Amsterdam). Int. J. Appl. Radiat. Isotop.; 23: No. 5, 239-41(May 1972).

A routine procedure was developed for the separation and determination of tracer amounts of HT, DT, and T_2, in connection with a study of the chemical behavior of recoiling T atoms produced by nuclear reactions in inorganic matrices. At the same time a method was required, for purely analytical purposes, for carrier amounts of H_2, HD, and D_2. Complete separation of all the species was achieved, within 15 min, using gas–solid chromatography on a 4 m copper column immersed in liquid N_2 and containing Al_2O_3. Either pure H_2 or a Ne/He mixture was used as carrier gas, H_2 being used where only the tritiated molecules were to be separated, or He/Ne where H_2, HD, and D_2 were to be determined. Details of the apparatus, experimental technique, and results are given, including a table of separation factors and a reproduction of the gas chromatograms. (UK)

38186 AUTOMATED COMBUSTION VERSUS DIGESTION FOR TRITIUM MEASUREMENT IN BIOLOGICAL SAMPLES. Hunt, L. M.; Gilbert, B. N. (Dept. of Agriculture, Kerrville, Texas). Int. J. Appl. Radiat. Isotop.; 23: No. 5, 246-9(May 1972).

A comparison was made between non-combustion methods and combustion methods in the analysis of ^{3}H-labeled materials in biological specimens. In the studies described sheep tissues were employed, including bone, blood and feces samples, and a dithiocarbamate fungicidal compound ^{3}H-labeled at the methyl group was used for the recovery determinations. In most of the layer tissue samples combustion efficiencies were not as high as expected, but this was due to an apparatus fault and a correction could be applied. Some of the more widely used digestion methods proved long and difficult, without necessarily resulting in high recovery efficiencies. The automated combustion method described had the advantages of speed (8 to 10 min per sample), with no apparatus clean-up between combustions, and high recovery efficiencies can be expected with a variety of biological samples and sample sizes. (UK)

38187 DETERMINATION OF NANOGRAM AMOUNTS OF BISMUTH IN ROCKS BY SUBSTOICHIOMETRIC ISOTOPE DILUTION ANALYSIS. Greenland, L. Paul; Campbell, E. Y. (Geological Survey, Washington, D. C.). Anal. Chim. Acta; 60: No. 1, 159-65(Jun 1972).

A rapid procedure suitable for the routine determination of 1 to 10 ng of bismuth in a silicate rock matrix is described. Results for U.S. Geological Survey standard rocks are presented. Rocks and minerals are dissolved in hydrofluoric–perchloric acid in the presence of ^{207}Bi tracer and the silica is removed by evaporation. The perchloric acid residue is taken up in water and bismuth iodide is extracted into methyl isobutyl ketone. After three acid–iodide washes, the bismuth is stripped into water and reacted with a substoichiometric amount of EDTA. Excess bismuth is extracted as the iodide and the specific activity of the bismuth–EDTA complex is determined. (auth)

38188 RADIOISOTOPE DETECTOR-RADIATOR ASSEMBLIES IN X-RAY FLUORESCENCE ANALYSIS FOR COPPER AND ZINC IN IRON-RICH MINERALS. Watt, J. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Int. J. Appl. Radiat. Isotop.; 23: No. 6, 257-64 (Jun 1972).

A description is given of a simple radioisotope x-ray technique of analysis for an element in samples containing high concentrations of another element of slightly lower atomic number. Sensitivity of analysis is achieved by use of a radiator foil whose fluorescent x-rays can be excited only by the higher of the two close-in-energy x-ray components from the sample, and by shielding the detector from the sample so that only radiator x-rays are detected. The sensitivity of this "detector-radiator assembly" to higher energy x-rays from the sample is overcome by "balanced-radiator" and other techniques. The sensitivity of the assembly as a function of energy of x-rays from the sample is calculated and measurements for various pure element samples given. A simple assembly which uses readily available radioisotope x-ray sources is used to demonstrate analysis for copper and zinc in various mineral products. (auth)

38189 OPTIMIZATION OF COUNTING OF SAMPLES WITH DOUBLE RADIOACTIVE LABELLING. Davies, P. T.; Deterding, J. H. (Shell Research Ltd., Chester, Eng.). Int. J. Appl. Radiat. Isotop.; 23: No. 6, 293-9(Jun 1972).

A criterion of performance is presented for counter experiments in which two nuclides present in a sample must be measured. A weighted sum of the activities of the two nuclides is minimized subject to a given precision being obtainable in a given counting time. Background counting rates and channel overlap can be allowed for. The procedures given can be used to compare instruments or instrument settings, and to estimate the amounts of radioactivity required for a tracer experiment. As a practical example, the method was applied to liquid scintillation counting of carbon-14 and tritium together. A single broad optimum was found, with optimum widths of the counting channels greater than those recommended by earlier workers. Strong background gave only a small reduction in the optimum channel widths. (auth)

38190 ^{134}Cs, ^{86}Rb AND ^{60}Co IN ^{99}Mo–^{99m}Tc GENERATOR ELUATE. Podolak, Edward M. Jr. (Analytical Quality Control Service, Winchester, Mass.). J. Nucl. Med.; 13: No. 6, 388-90 (Jun 1972).

A review is given of separate investigations on ^{99}Mo–^{99m}Tc generators. ^{134}Cs, ^{86}Rb, and ^{60}Co are identified as radioactive contaminants in the ^{99}Mo–^{99m}Tc generator eluate. ^{134}Cs, ^{124}Sb, ^{95}Zr–^{95m,95}Nb, ^{65}Zn, and ^{60}Co are identified as radioactive contaminants on an alumina column from a one-year-old ^{99}Mo–^{99m}Tc generator. The Ge(Li) detector is shown to be an indispensable tool for the positive identification of ^{99m}Tc contaminants whose gamma energies may differ by only a few thousand electron volts. (auth)

38191 MEASUREMENT OF THE SPECIFIC RADIOACTIVITY WITH RESPECT TO PARTICLE SIZE FOR LABELED AEROSOLS. Kotrappa, P.; Wilkinson, C. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). J. Aerosol Sci.; 3: No. 3, 167-71(May 1972).

The relationship between labeled radioactivity and particle size is an important characteristic of a labeled aerosol. Measurements were made of the specific activity of labeled fused clay aerosols using the following methods: (1) dividing the aerosol into several narrow size groups using the Lovelace Aerosol Particle Separator (a spinning spiral spectrometer similar to that of Stöber), (2) determining the radioactivity per particle by counting the number of particles and the radioactivity associated with a known area, (3) determining the relationship between relative radioactivity per particle and particle size, and (4) dividing the function thus obtained by the cube of the particle diameter. Fused clay aerosols labeled with ^{91}Y, ^{90}Sr–^{90}Y, ^{144}Ce–^{144}Pr and ^{137}Cs–^{137}Ba had the relative radioactivity proportional to the cube of the particle size, thus demonstrating that the specific activity is independent of particle size. Fused clay aerosol labeled with ^{106}Ru–^{106}Rh had a relationship other than cubic, demonstrating particle size dependence of specific activity, probably because of the volatility of Ru under heat treatment. Adaptation of this method as a general method for characterizing labeled aerosols is discussed. (auth)

38192 DETERMINATION OF ^{226}Ra IN BONE TISSUE. Novikova, N. Ya.; Voronina, T. F.; Golovunin, V. N. (Inst. of Biophysics, Moscow). Gig. Sanit.; No. 2, 84-6(Feb 1972). (In Russian).

In this method of ^{226}Ra determination, bone ash is treated with concentrated HCl, a known amount of ^{133}Ba is added, and the combined sulfates of Ba and Ra are precipitated using dilute H_2SO_4. Much of the Ca, Na, K, and PO_4^{3-} remain in solution. The filtered sulfate precipitate is dissolved in EDTA (Na salt), and the resulting solution is assayed for ^{133}Ba by a spectrometric measurement of gamma activity in order to establish the chemical yield of ^{226}Ra. The solution is finally sealed in glass for 4 to 7 days, and the accumulated Rn is measured by an α count. The over-all error of the method is ±20%. If it is not possible to employ ^{133}Ba to establish the loss of Ra during the procedure outlined, it is recommended that a yield of ^{226}Ra of 85% be taken as a rough average. (K.S.W.)

38193 DETERMINATION OF ^{90}Y, ^{90}Sr, AND ^{89}Sr IN SAMPLES BY USE OF LIQUID SCINTILLATION BETA SPECTROSCOPY. Piltingsrud, H. V.; Stencel, J. R. (Wright Air Development Center, Wright-Patterson AFB, Ohio). Health Phys.; 23: No. 1, 121-2(Jul 1972).

A routine method is described that consists of suspending a precipitate of the ^{90}Y, ^{90}Sr, and ^{89}Sr as carbonate in a liquid scintillator containing a gelling agent and determining the quantity of these three isotopes in the sample by a newly developed technique involving scintillation beta spectroscopy, coupled with a spectrum-unfolding computer program. In the trials described, the liquid scintillator mixture contained PPO, POPOP, naphthalene, water, CaB−O−Sil, and dioxane. With the instrumentation employed, the minimum detectable activities for 800 min. counts were of the order of 1 pCi. Experience with this procedure indicates that the method is sensitive and effective, and solves a number of problems previously encountered. (UK)

Separation Procedures

Refer also to abstract 38580.

38194 (IFA-MN-14) RESEARCH ON OBTAINING HAFNIUM OF NUCLEAR PURITY. Popa, Lucretia; Arsenie, Ioana (Institutul de Fizica Atomica, Bucharest (Romania)). Sep 1971. 10p. (In French). Dep. NTIS (U. S. Sales Only).

Two resins, Dowex 3 and Nionit AT 1, were used for the ion exchange separation of zirconium and hafnium from sulfate solutions. Sulfuric acid was used as the eluent. The order of elution of the components as a function of the acidity of the eluent was established. Analyses of Zr and Hf were made by radioactivation and γ spectrometry. (J.G.B.)

38195 (RT/CHI-(71)15) PRELIMINARY STUDY REGARDING THE OXIDATION-REDUCTION INTERACTION BETWEEN THE VALENCE STATES OF NEPTUNIUM AND TERTIARY AMINE AS EXTRACTANT. Basili, N.; Delle Site, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 25 Oct 1971. 23p. (In Italian). Dep. NTIS (U. S. Sales Only).

The behavior of neptunium in extraction by tertiary amines is complicated because of redox reactions that take place principally in the organic phase. The IV, V, and VI valence states of neptunium are involved in these reactions, as demonstrated by spectrophotometric analysis of both phases and by determining the distribution coefficients of the element in these different oxidation states. The results indicate that, irrespective of the nature of the ion present in the phases before their contact, the system shows a tendency to establish an equilibrium: $\mathrm{Np(IV)_{org}} \rightleftharpoons \mathrm{Np(V)_{acq}}$. The presence of nitrous acid accelerates the reduction of Np(VI) to Np(V) and increases its back extraction. (auth)

38196 EXTRACTION OF ALKALINE EARTH METALS BY THE DIBUTYL ESTER OF PHENYLSULFONYLAMIDOPHOSPHORIC ACID. Shevchenko, F. D.; Ageev, V. A.; Sazhenyuk, A. D. (Kiev State Univ.). Zh. Neorg. Khim.; 17: No. 1, 204-6 (Jan 1972). (In Russian).

The extraction of alkaline earth metals by benzene solutions of dibutyl phenylsulfonylamidophosphate ($C_6H_5SO_2NHPO(OC_4H_9)_2$) was studied as a function of the pH of the aqueous phase at various concentrations of reagent. The alkaline earth metals passed over into the benzene solution as the complexes: $CaA_2 \cdot 2HA$, $SrA_2 \cdot 3HA$, and $BaA_2 \cdot 3HA$. The optimum conditions of extraction were determined and the equilibrium constants of the reactions studied were calculated. (tr-auth)

38197 EXTRACTION OF SCANDIUM BY TBP FROM NITRATE SOLUTIONS WITH ACID DEFICITS. Korovin, S. S.; Zhambulova, M. Sh.; Klyuchnikov, V. M.; Apraksin, I. A. Zh. Neorg. Khim.; 17: No. 1, 207-10(Jan 1972). (In Russian).

The extraction of Sc from acid-deficient nitrate solutions established the formation in the organic phase of the complexes $Sc(OH)(NO_3)_2 \cdot nTBP$ and $Sc_2(OH)_2(NO_3)_4 \cdot 2nTBP$, where n = 2 or 3. In the extraction of Sc from solutions characterized by the ratio $[OH^-]/[Sc] = 1.5$ to 2.0, in all probability the extracted form is the complex $Sc_2O(OH)(NO_3)_3 \cdot 2nTBP$. Nitrato groups exist in the coordination sphere of the Sc atom in the extracted hydroxy compounds. (tr-auth)

38198 DEPENDENCE OF THE EXCHANGE RATE OF RARE EARTH IONS BETWEEN CATION EXCHANGER AND A SOLUTION OF EDTA ON THE FORM OF INTRODUCING THE COMPLEXING AGENT. Yashkarova, M. G.; Martynenko, L. I.; Spitsyn, V. I. (Moscow State Univ.). Zh. Neorg. Khim.; 17: No. 1, 218-21(Jan 1972). (In Russian).

The exchange rate of ions of the rare earth elements between an EDTA solution and a cation exchanger was studied by means of the non-equilibrium constants of separation of mixtures of Nd−Pr and of Er−Ho. A non-identical exchange mechanism was realized for systems at different dilutions, pH, and mixtures of the rare earths. (tr-auth)

38199 EXTRACTION OF ZIRCONIUM AND SCANDIUM BY A MIXTURE OF BENZOYLACETONE AND HEPTYLPHOSPHORIC ACID TETRAETHYLDIAMIDE. Fadeeva, V. I.; Putilina, V. S.; Alimarin, I. P. (Moscow State Univ.). Zh. Neorg. Khim.; 17: No. 3, 771-5(Mar 1972). (In Russian).

The extraction of Zr and Sc by benzene solutions of benzoylacetone in the presence of donor-active heptylphosphoric acid tetraethyldiamide from nitric, perchloric, and hydrochloric acids was studied. A synergistic reinforcement of extraction of scandium and zirconium benzoylacetonates was associated with the formation of mixed complex compounds in the organic phase. The extraction mechanism is discussed. (tr-auth)

38200 EXTRACTION OF HYDROXYNITRATES OF ZIRCONIUM AND HAFNIUM BY TBP. Klyuchnikov, V. M.; Zaitsev, L. M.; Korovin, S. S.; Solov'eva, E. S.; Apraksin, I. A. Zh. Neorg. Khim.; 17: No. 3, 780-2(Mar 1972). (In Russian).

The extraction of Zr and Hf from aqueous solutions by TBP was studied, wherein the aqueous phase contained oxychlorides and nitrates of Na, Li, or Ca. Zr and Hf could be extracted by TBP from solutions having an acid deficiency, passing over into the organic phase as hydroxynitrates. In contrast, Zr and Hf extracted from acid solutions into TBP as disolvates. The extraction of Zr and Hf hydroxynitrates proceeded in the form of complexes with the ratio Me : TBP = 1 and 2. (tr-auth)

38201 EXTRACTION OF MOLYBDENUM BY TBP FROM PEROXIDE SOLUTIONS. Zelikman, A. N.; Bol'dman, G. M.; Kagerman'yan, V. S. Zh. Neorg. Khim.; 17: No. 3, 783-9 (Mar 1972). (In Russian).

The composition and structure of Mo peroxy complexes in HNO_3 and TBP were studied with ir and uv spectroscopy. Instability constants of diperoxydimolybdenum anion in aqueous solution were measured. Extraction of the Mo peroxy complex by TBP occurs through a hydrate−solvate mechanism with formation of $[H_3O(H_2O)_3 \cdot 3TBP^+]_2[Mo_2O_{11}(H_2O)_2^{2-}]$. The apparent equilibrium constant of extraction was calculated. (tr-auth)

38202 EXTRACTION OF MACRO QUANTITIES OF CERIUM (III) FROM NITRIC ACID SOLUTION BY DI-p-CRESYL PHOSPHATE. Fomin, V. V.; Potapova, S. A. Zh. Neorg. Khim.; 17: No. 3, 796-9(Mar 1972). (In Russian).

Macro quantities of Ce(III) were extracted from nitric acid solutions by a chloroform solution of di-p-cresyl phosphate (DCPA). When the $CHCl_3$−DCPA solution was saturated with the Ce complex formed, $CeAn_3$ separated out, where An represents the anion form of DCPA. With a moderate excess of the extractant (with respect to Y present), the soluble compound $CeAn_3 \cdot 2HAn$ is formed. The concentration of the latter depends on the concentration of free DCPA. (tr-auth)

38203 ION EXCHANGE SEPARATION OF TELLURIUM(IV) AND SELENIUM(IV) FROM LOW-CONCENTRATION ALKALINE SOLUTIONS. Vasilev, Kristo; Petkova, Elisaveta. Rudodobiv Met. (Sofia); 26: No. 3, 52-5(1971). (In Bulgarian).

The exchange capacity (C) of ion-exchange resins Wofatit SBW (I) (a strongly alkaline anionic resin), EDE-10P, Wofatit L-150, Wofatit P, Wofatit KPS-200, and Wofatit F (in the OH^- or Na^+ forms; the first 3 are anionic, and the last 3 are cationic) for Te, from 0.1N NaOH (containing 1.13 g Te/cm^3), is 115.0, 41.0, 41.5, 20.0, 36.5, and 35.0 mg/g, respectively. The C for Te and Se decreases with increasing OH^- concentration in the solution (0.01 to 2.0N NaOH). The optimum solution for the sorption of Te(IV) and Se(IV) on I is 0.01 to 0.1N NaOH; the Se is eluted quantitative with 8N HCl (this removes also 19% of the sorbed Te), and the Te is then eluted with 2N NaOH. The sorption of Te on I is selective in the presence of Si(IV), As(III), and Cl^- ions, and the separation factors, T, for the Te−Si, Te−As(III), and Te−Cl pairs are 1.85, 3.86, and 5.65 respectively; however, T for the Te−As(V) and Te−S(VI) pairs are 0.169 and 0.554, respectively, i.e., sorption of As(V) and S(VI) is preferential. (Selenium-Tellurium Abstr.)

38204 EXTRACTION OF MACRO QUANTITIES OF YTTRIUM FROM NITRIC ACID SOLUTIONS BY DI-p-CRESYL PHOSPHATE. Fomin, V. V.; Potapova, S. A. Zh. Neorg. Khim.; 17: No. 3, 790-5(Mar 1972). (In Russian).

Macro quantities of Y were extracted from 0.1 N and 1.0 N HNO_3 by means of a chloroform solution of di-p-cresyl phosphate (DCPA). In the case of a deficiency of DCPA, an insoluble compound YAn_3 forms, where An represents the anion of DCPA. With a moderate excess of the extractant, YAn_3 separates out and goes into solution in the organic phase as the complex $YAn_3 \cdot 2HAn$. The formation constant of the dissolved Y compound depends largely on the nature of the solvent. (tr-auth)

38205 NON-ION EXCHANGE SORPTION OF MONOIMINODIACETATES OF THE RARE EARTH ELEMENTS BY A CATION EXCHANGER. Martynenko, L. I.; Kupriyanova, G. N.; Prutkova, N. M. (Moscow State Univ.). Zh. Neorg. Khim.; 17: No. 1, 214-17(Jan 1972). (In Russian).

Chemical and spectrographic investigations were made of the eluate composition which was formed during washing of a cation exchanger containing rare earths by a solution of iminodiacetic acid. Separation of the rare earths was accomplished through the formation of mono- and diiminodiacetates. The monoiminodiacetate, a complex of the form [NdZ]HZ, was absorbed by the resin in the rare earth form on account of non-ion exchange sorption and plays a role in the process of ion exchange. (tr-auth)

38206 EXTRACTION OF SOME METAL PHENYLACETATES INTO CHLOROFORM. Adam, Jiri (Charles Univ., Prague); Pribil, Rudolf; Vesely, Vladimir. Talanta; 19: No. 6, 825-7 (Jun 1972).

Phenylacetic acid was found to be very useful as a reagent in the extraction of large quantities of certain ions, notably iron(III), cobalt(II), copper(II), lead, zinc, cadmium, and uranyl. A 1M solution of the reagent in chloroform is used to extract up to 200 mg of certain ions from small volumes of aqueous phase. Selectivity is increased by pH control and masking. (UK)

38207 DERIVATION OF ADEQUATE MATHEMATICAL MODELS FOR THE EXTRACTION OF ZIRCONIUM AND HAFNIUM BY ALCOHOLS USING CONFLUENT ANALYSIS. Smirnova, N. S.; Nikolaeva, L. S.; Granovskii, Yu. V.; Komissarova, L. N. (Moscow State Univ.). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 10, 1569-70(Oct 1971).

Translated from Zavod. Lab.; 37: No. 10, 1224-5(Oct 1971).

By the use of confluent analysis, adequate mathematical models were derived for the extraction of Hf and Zr using hexanol and 1-decanol. Optimization parameters were derived for the case of heptanol. The coordinates of the conditional extremum were calculated for this same case, and the values of the optimization parameters at the conditional extremum points were close to the best results attained when a complete set of experiments was carried out for the calculated design. (B.L.M.)

38208 SORPTION OF MOLYBDENUM BY A MODIFIED ANION EXCHANGER AV-17. Kholmogorov, A. G.; Nadol'skii, A. P.; Il'ichev, S. N.; Kobaleva, M. P. Tsvetn. Metal.; No. 12, 41-5(Dec 1971). (In Russian).

The anion exchanger AV-17 of an industrial grade may be used for extracting Mo from alkaline and weakly alkaline solutions (to pH = 5) without a complex salt composition. The exchanger AV-17P of a porous structure may be used over a wide pH range (both acid and base). For sorbing Mo from solutions with a complex salt composition (NaCl leaching, electrochemical oxidation, ammonium molybdate production), it is more expedient to utilize AV-17P of a macroporous structure at a pH of 4. (tr-auth)

38209 SUPPRESSION OF MICROELEMENT EXTRACTION DURING INDIUM REMOVAL FROM BROMIDE SOLUTIONS BY TBP. Sokolov, A. B.; Zolotov, Yu. A. Zh. Neorg. Khim.; 17: No. 4, 1123-6(Apr 1972). (In Russian).

The extraction of Zn, Te(IV), Tl(III), Ag, Sn(IV), Co, Bi, Sc, Sb(III), Hg, and Cd (10^{-5} to 10^{-4} mole/l) by TBP from HBr solutions in the presence of In (10^{-3} to 1.5 mole/l) was investigated. The distribution coefficients of the ions listed were determined as functions of the In concentration, at constant HBr concentration, and also as functions of the HBr concentration at constant In concentration. Extraction of these microelements was also studied in the absence of macroelements. The tendency of the majority of microelements to extract decreased significantly in the presence of In, the distribution coefficients often being decreased by a factor of 10,000. Co-extraction in the case of Sc was observed. Reduced extraction of the microelements was associated with the dissociation of complex acids in the TBP phase. (tr-auth)

38210 URANYL(VI) EXTRACTION FROM ACETATE SOLUTIONS IN THE PRESENCE OF TETRAKISDECYLAMMONIUM ACETATE. Lipovskii, A. A.; Kuzina, M. G. Zh. Neorg. Khim.; 17: No. 4, 1127-31(Apr 1972). (In Russian).

The extraction of U(VI) from acetate solutions aided by solutions of tetrakisdecylammonium acetate in benzene was investigated. Various uranyl complexes were formed depending on the pH and on the ratios of the reactants, $UO_2Ac_2 : R_4NAc$, in the original reacting solutions. With an excess of reagent, and at a pH < 5.0, $R_4N(UO_2)Ac_3$ or $(R_4N)_2UO_2Ac_4$ extracted. At a pH > 5.0, mixed acetate complexes $R_4N(UO_2)Ac_2OH$ and $(R_4N)_2UO_2Ac_2(OH)_2$ extracted. With a deficit of reagent, the species extracted might be $R_4N(UO_2)_2Ac_3(OH)_2$ or $(R_4N)_2(UO_2)_3Ac_6(OH)_2$, depending on the concentration of UO_2Ac_2. (tr-auth)

38211 SELECTIVITY OF SULFONATE CATION RESINS IN CONCENTRATED SULFATE SOLUTIONS. Nikolaev, A. V.; Sokolova, N. P. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk; No. 3, 34-40(May 1971). (In Russian).

The ion exchange systems Li^+-H^+, K^+-H^+ and Cs^+-H^+ on sulfonate cation resin KY-2 × 8 in the sulfate solutions of total concentrations 0.1 to 4 M were studied. Increasing of the selectivity coefficient can be assumed to be caused by association of a proton with the sulfate anion. (auth)

38212 SPECIFIC SEPARATION OF GALLIUM, GOLD, AND MAGNESIUM, AND SEPARATION OF Be—Al—Ga ON STANNIC MOLYBDATE PAPERS. Qureshi, M.; Rawat, J. P. (Aligarh Muslim Univ., India). Separ. Sci.; 7: No. 3, 297-301(1972).

Chromatography of 47 cations in 11 solvent systems was performed on stannic molybdate ion exchange papers. Some difficult separations, e.g., Rb from Cs, Al—Be—Ga, and Tl—In, and specific separations of Ga, Au, and Mg from numerous metal ions, were achieved. R_F values of some common metal ions on these papers were compared with R_F values of these cations on stannic tungstate and stannic phosphate papers. The preparation of papers is easy and the results are reproducible. (auth)

38213 SOLVENT EXTRACTION OF NIOBIUM AND TANTALUM. VIII. EXTRACTION WITH SOME BIDENTATE PHOSPHORUS COMPOUNDS FROM SULFATE SOLUTIONS. Sevdic, D.; Meider-Gorican, H. (Inst. Rudjer Boskovic, Zagreb). J. Less-Common Metals; 27: No. 3, 403-9(Jun 1972).

The extraction of niobium and tantalum from sulfate solutions with bis(di-n-hexylphosphinyl)methane $[(C_6H_{13})_2OPCH_2PO(C_6H_{13})_2]$; di-n-octyl 1-oxooctanephosphonate $[C_7H_{15}COPO(OC_8H_{17})_2]$; and di-n-octyl 2-oxo-propanephosphonate $[CH_3COCH_2PO(OC_8H_{17})_2]$ was studied. The ligand/metal and hydrogen/metal ratios were determined by slope analyses. On the basis of the evidence obtained, the extraction mechanism was deduced. In the systems investigated at low acidity in the aqueous phase, the presence of the extraction species $Me(OH)_4L \cdot HL_n$ (n = 1 or 2) and $Me(OH)_3L_2$ (Me = Nb, Ta) in the organic phase has been proposed. (auth)

38214 INFLUENCE OF A SOLVENT ON THE EXTRACTION OF Am(III) AND Eu(III) BY THE MIXTURE OF REAGENTS. Kochetkova, N. E.; Chmutova, M. K.; Myasoedov, B. F. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 27: No. 4, 678-81(Apr 1972). (In Russian).

The effects of organic solvents on a synergistic effect in the extraction of Am and Eu by the mixture of 4-benzoyl-3-methyl-1-phenyl-2-pyrazolin-5-one (FMBP) and TBP were studied. The greatest synergistic effect occurs in solvents of lowest dielectric constants. The use of mixtures of solvents helps to increase the solubility of FMBP and, hence, improves extraction of Am and Eu from solutions of increasing acidity. The dilution of the extract with a solvent, suppressing the synergistic effect, allows use of acids in a wide concentration range. (auth)

38215 DETERMINATION OF STABILITY CONSTANTS OF SOME CHELATE COMPLEXES OF LANTHANIDE IONS WITH QUADRIDENTATE AROMATIC SCHIFF BASES BY AN EXTRACTION METHOD. XIV. RADIOTRACER STUDIES ON THE EXTRACTION OF METAL IONS. Rekas, Mieczyslaw (Inst. of Solid State Chemistry, Krakow); Stronski, Ignacy; Zielinski, Andrzej. Z. Phys. Chem. (Leipzig); 249: No. 3-4, 145-53(1972).

The dependence of the free ligand concentrations and pH on the distribution ratio, D, of tervalent Eu, Tb, and Tm ions was investigated, applying a radiotracer method and bis-salicylaldehydeethylenediimine (BSEDI) and bis-3-methoxysalicylaldehydeethylenediimine (B-3-MoxSEDI) as chelating agents. The method of calculating the stability constants, pβ, of chelates of Eu^{3+} with BSEDI and B-3-MoxSEDI is given. It was found that aromatic, quadridentate Schiff bases could be used for the extraction of small quantities of lanthanide ions. The stability constants of these chelates increased regularly with the increase of atomic number, Z, of metals. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 38896, 38897, and 39859.

Chemical and Physico-chemical Properties

Refer also to abstracts 38312, 38322, 38341, and 38903.

38216 (MHSMP-72-31) EFFECTS OF VARIOUS ENVIRONMENTAL CONDITIONS ON RECRYSTALLIZED PETN. Duncan, A. A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. Development Div.). Apr 1972. Contract DA-11-173-AMC-487(A). 212p. Dep. NTIS.

Pentaerythritol tetranitrate (PETN) was examined with primary emphasis on the factors and physical parameters affecting particle surface, size, and shape stability. The effects of elevated temperature, sample confinement, elevated and reduced pressure, and solvent reaction rates were studied. Weight loss as a function of temperature and pressure as related to surface area was examined. The various techniques used in recrystallization are also considered. (M.C.G.)

38217 (ORNL-TM-3071) LMFBR FUEL MATERIALS CONVERSION DEVELOPMENT: A PARTIAL TECHNICAL EVALUATION. Haas, Paul A. (comp.) (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 98p. Dep. NTIS.

The Liquid Metal Cooled Fast Breeder Reactor (LMFBR) fuel materials conversion program includes the chemical conversions, shipping, and storage required starting with purified plutonium and uranium products from spent fuel at reprocessing plants and ending with fuel material delivered to the fuel refabricator. Results of a partial technical evaluation of these operations are presented. The principal objective of the evaluation was to show interrelations among the operations to provide guidance for any development work found to be necessary. The proposed program is based on conversion of nitrate solutions to oxides at the reprocessing plant and subsequent shipment of dry solids. The most completely developed conversion processes involve preparing powders by precipitation followed by controlled drying and firing. The selection of conversion processes for additional development will be based on three factors: technical feasibility, irradiation behavior and performance characteristics of the fuel produced, and economics. Additional information on radiation shielding, criticality, accountability, hardware, process optimization, and adaptability to scale-up is needed. The overall conversion development program must be carried out in the larger context of fuel refabrication development. In this regard, a solid form of plutonium that can be fabricated directly, or can be easily dispersed to produce a nitrate solution for use by the fabricator, is highly desirable. (auth)

38218 (ORNL-tr-2593) MOLLIER DIAGRAMS FOR EVALUATING NUCLEAR HEAT PROCESSES FOR DECOMPOSITION OF WATER. Knoche, K. F.; Schybert, J. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from VDI (Ver. Deut. Ing.)-Forsch.; No. 549, 25-32(1972). 21p. Dep. NTIS.

Nonelectrolytic processes for decomposition of water are reviewed. Conditions of the first and second laws of thermodynamics for the thermal decomposition of water are discussed. Chemical reactions at constant temperature and pressure in the Mollier enthalpy–entropy diagram are described. Thermodynamic conditions for a two-stage process are also considered, along with a multistage process using iron and chlorine. (M.C.G.)

38219 DISSOCIATION ENERGIES OF THE GASEOUS DICARBIDES OF THE RARE EARTHS. Filby, E. E.; Ames, L. L. (New Mexico State Univ., Las Cruces). High Temp. Sci.; 4: No. 2, 160-9(Apr 1972).

A Knudsen-cell mass spectrometric method was used to study C_2-exchange reactions of the type $M_aC_2(g) + M_b(g) = M_a(g) + M_bC_2(g)$, where M_a and M_b are two different rare earth metals. Five different combinations were studied, including Tb–Dy, Ho–Dy, Er–Ho, Er–Tm, and Nd–Ho, and dissociation energies of the gaseous dicarbides were determined from the enthalpies of the exchange reactions coupled with a known value (162 ± 2 kcal/mole) for the CeC_2 dissociation energy and previously reported reaction enthalpies. The dissociation energies are 133 ± 4 kcal/mole for DyC_2, 134 ± 3 kcal/mole for HoC_2, 135 ± 3 kcal/mole for ErC_2, and 119 ± 4 kcal/mole for TmC_2. Trends in the heats of formation and sublimation of the rare earth dicarbides as a whole were used to estimate dissociation energies of 116 ± 7 kcal/mole for SmC_2, 98 ± 8 kcal/mole for EuC_2, 90 ± 10 kcal/mole for YbC_2, and 156 ± 12 kcal/mole for LuC_2. The dissociation energies show a double periodicity in their variation with atomic number which closely matches the variations of the dissociation energies of the rare earth monochalcogenides and of the heats of sublimation for the rare earth metals. The double periodic pattern of the dicarbide dissociation energies is shown to correspond to the magnitudes of the $4f^n \rightarrow 4f^{n-1}$ 5d transition energies of the divalent rare earth ions. The success of this approach lends support to the consideration of the C_2^{2-} ion as a "pseudo-oxide" or, more generally, a "pseudochalcogenide". (auth)

38220 VISCOSITY OF HEAVY WATER AT HIGH PRESSURES IN THE 100 TO 275^{0}C TEMPERATURE RANGE. Agaev, N. A.; Kerimov, A. M.; Abas-Zade, Azad. This paper was summarized in At. Energ. (USSR); 30: No. 6, 534-5(Jun 1971) as paper No. 498/5559. (In Russian).

Full copy of this paper is held by TIC.

Results of an experimental study of the viscosity of heavy water at pressures of 1 to 1200 kg/cm^2 and temperatures of 100 to 275°C, including measurements near the saturation line, are given. The measurements were done using an experimental instrument for determining the viscosities of liquids and gases at high pressures. The heavy water was 99.8 at.% pure. Experiments were performed along isotherms; measurements were made two or three times at each temperature–pressure point, with an experimental reproducibility of ±0.1 to 0.2%. The maximum relative experimental error was ±1%; the Reynolds number did not exceed 500 in the experiments. Experimental values are presented. These values deviate from those in the literature by not more than 1 to 2%. (auth)

38221 MODEL CALCULATIONS ON THE INFLUENCE OF QUANTUM ELECTRODYNAMICAL EFFECTS ON THE CHEMISTRY OF SUPERHEAVY ELEMENTS. THE CHEMISTRY OF ELEMENT E184. Fricke, B.; Waber, J. T. (Northwestern Univ., Evanston, Ill.). J. Chem. Phys.; 57: No. 1, 371-6(1 Jul 1972).

Using a phenomenological model, the influence of quantum electrodynamical effects on the prediction of the chemical behavior of superheavy elements within a relativistic Dirac–Slater calculation was investigated. This influence will be small and nondetectable for elements up to Z = 114. For elements near Z = 164 some changes in the ground state configurations occur but the chemical behavior will not change. Using this heuristic model, it is also possible to calculate elements beyond Z = 175. As an example element E184 was chosen and now more valid speculations may be made about the chemical behavior of the element than Penneman and co-workers could. (auth)

Isotope Effects

38222 KINETIC ISOTOPE EFFECTS IN THE REACTION OF METHYL RADICALS WITH MOLECULAR HYDROGEN. Shapiro, J. S.; Weston, R. E. Jr. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem.; 76: No. 12, 1669-79(8 Jun 1972).

The photolysis of acetone and acetone-d_6 was used as a source of CH_3 and CD_3 radicals, which subsequently abstract a hydrogen atom from acetone or from added hydrogen. Relative rate constants for abstraction from various isotopic species of hydrogen were determined over the temperature range of 398 to 718°K by carrying out the photolysis in the presence of H_2–D_2 mixtures or of HD. At each temperature, a series of experiments at different acetone/hydrogen ratios enables one to correct for hydrogen abstraction from the radical source. Mass spectrometric analysis of the resulting methane provides a measurement of the isotope effect. The experimental rate constant ratios are compared with those calculated on the basis of LEPS and BEBO models of the activated complex. (auth)

38223 APPLICATION OF THE m-6-8 POTENTIAL TO SIMPLE GASES. Hanley, H. J. M. (National Bureau of Standards, Boulder, Colo.); Klein, Max. J. Phys. Chem.; 76: No. 12, 1743-51(8 Jun 1972).

The m-6-8 model potential function was applied to the gases argon, krypton, xenon, nitrogen, methane, and carbon dioxide and to the properties viscosity coefficient, self-diffusion coefficient, thermal conductivity coefficient, virial coefficient, and the isotopic thermal diffusion factor. The potential is shown to have a considerable advantage over previous simple analytic models in that it can satisfy two criteria: (a) it can be used to correlate a given property for all the gases studied over a wide temperature range with a single set of parameters, and (b) it can be used to correlate both transport and equilibrium properties for the monatomic gases with a single set of parameters. Reasons for the failure of polyatomic gases to satisfy (b) are suggested. A brief discussion on the relation of the potential to theory is given. (auth)

38224 ELECTRONIC TRANSITION AND ISOTOPIC EFFECT FOR ^{72}GeO AND ^{74}GeO MOLECULES. Korzh, P. D.; Kuznetsova, M. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 31: No. 4, 286-8(Oct 1971).

Translated from Opt. Spektrosk.; 31: No. 4, 539-41(Oct 1971).

The emission spectra of the isotropic molecules ^{72}GeO and ^{74}GeO were measured. The rotational structure of the 0–1, 0–2, 0−3, and 0−4 bands was investigated and their zero lines calculated. The principal system of bands (3300−2200 Å) is due to $^1\Pi-^1\Sigma$ transitions. The rotational constants of the ground states of the isotopic molecules were found, and the isotopic shift was determined. (auth)

38225 MASTER EQUATION FOR THE DISSOCIATION OF A DILUTE DIATOMIC GAS. VI. SOLUTION OF COUPLED SETS OF MASTER EQUATIONS. McElwain, D. L. S.; Pritchard, H. O. (York Univ., Downsview, Ont.). Can. J. Chem.; 50: No. 6, 897-906(15 Mar 1972).

Three coupled sets of master equations, representing the equilibration of $X_2 + Y_2 \rightleftharpoons 2XY$ via atoms only, were solved by the normal-mode technique; the set of 57 simultaneous differential equations describing the $H_2/D_2/2HD$ system was considered as a suitable trial model. It was found that at times (t) in excess of the longest vibrational relaxation time, even though some of the populations in the system appeared highly non-Boltzmann, all the phenomenological rate constants were well-behaved: they were either constant and obeyed the rate−quotient law, or they were dependent on t^2. The information required before a full solution of the $X_2 + Y_2 \rightleftharpoons 2XY$ reaction could be contemplated is discussed, and methods by which an approximation to such a solution could be obtained are suggested. (auth)

38226 2,4-DIAZAPENTADIENES. II. A CARBANION CYCLIZATION. Hunter, D. H.; Sim, S. K. (Univ. of Western Ontario, London). Can. J. Chem.; 50: No. 5, 678-89(1 Mar 1972).

The mechanism of the cyclization and 1,3-proton shift of 1,3,5-triaryl-2,4-diaza-1,3-pentadienes catalyzed by phenyllithium and by potassium methoxide−methanol was studied. On the basis of substituent effects, hydrogen−deuterium exchange, isotope effects, and solvent effects, it was deduced that both the cyclization and prototropy involve a common W-shaped carbanion, which rapidly cyclizes. A kinetic deuterium isotope effect of 2 was calculated for protonation of this intermediate carbanion in methanol. (auth)

38227 MECHANISM FOR HYDROLYSIS OF PRIMARY ALKYL CHLOROSULFATES IN WATER. THE KINETIC SOLVENT ISOTOPE EFFECT AND THE SECONDARY DEUTERIUM ISOTOPE EFFECT. Ko, E. C. F.; Robertson, R. E. (Univ. of Calgary, Alberta). Can. J. Chem.; 50: No. 3, 434-7(1 Feb 1972).

The temperature coefficients of the enthalpy of activation ($\Delta C_p^{\ddagger}$) for the hydrolysis of the three chlorosulfates, methyl, ethyl, and β-chloro, are shown to have values of −50, −55, and −60 cal deg^{-1} mol^{-1}; values in the same range as previously reported for the hydrolysis of the sulfonyl chlorides. The corresponding value for the β-methoxy isomer was −40 cal deg^{-1} mol^{-1}, about the same as found for the p-methoxybenzenesulfonyl chloride. The kinetic solvent isotope effect, however, was significantly lower than reported for the sulfonyl chloride series, being about the same as found for the hydrolysis of the alkyl halides. While some degree of nucleophilic overlap is probably required in the activation process, the requirement here is reduced to about the same level as that for the primary halides, and there is no need to postulate a different mechanism on passing from the methyl to the ethyl member of the series, confirming the earlier conclusion of Buncel and Millington. (auth)

38228 DEUTERIUM ISOTOPE EFFECTS IN THE REDUCTION OF CYCLOHEXANONES. THE CONCEPTS OF STERIC APPROACH CONTROL AND PRODUCT DEVELOPMENT CONTROL. Wigfield, Donald C.; Phelps, David J. (Carleton Univ., Ottawa). Can. J. Chem.; 50: No. 3, 388-94(1 Feb 1972).

Definitions for the terms steric approach control and product development control in relation to the degree of bonding in the transition state are put forward. Kinetic deuterium isotope effects in the reduction of a graded series of ketones by $NaBH_4$ and $NaBD_4$ were measured. These effects are inverse, and show no systematic dependence on the degree of steric hindrance of the ketone. This evidence appears to invalidate the steric approach control−product development control explanation of the axial to equatorial product ratios. The primary isotope effect is very small, which is consistent with an early transition state in these reductions, as demanded by other explanations of product ratios, but since several other factors causing small isotope effects may be applicable, the evidence does not constitute proof of an early transition state. (auth)

38229 ENERGY DISTRIBUTIONS OF REACTION PRODUCT BY STATISTICAL PHASE SPACE THEORY. Wong, W. H. (Univ. of Illinois, Urbana). Can. J. Chem.; 50: No. 5, 633-40 (1 Mar 1972).

The phase space theory of chemical reaction in which all accessible channels are uniformly weighted was shown to be inappropriate for describing exothermic reactions. Modification to the theory was introduced by a concept of partial statisticity in which only that portion of the phase space available to each vibrational level was treated statistically. The product rotational and translational distributions of the reaction, Cl + HI, and its isotopic variant, Cl + DI, were computed by this modified formulation and compared with that obtained from a straight application of the phase space theory. The implication of the profound differences found from these two formulations was discussed in light of experimental data. (auth)

38230 HYDROLYSIS OF SULFAMOYL CHLORIDES. II. HYDROGEN PARTICIPATION IN THE HYDROLYSIS OF DIETHYL AND METHYLETHYLSULFAMOYL CHLORIDES. Ko, E. C. F.; Robertson, R. E. (Univ. of Calgary, Alberta). Can. J. Chem.; 50: No. 6, 946-51(15 Mar 1972).

Diethylsulfamoyl chloride (2) hydrolyzes eight times faster than dimethylsulfamoyl chloride (1). In 2 the secondary deuterium isotope effect was found to be about 2, hence hydrogen participation is important in the hydrolysis of this compound. The temperature coefficient of the enthalpy of activation ($\Delta C_p^{\ddagger}$) is exceptional (−39 cal mol^{-1} deg^{-1}) for a reaction presumably following an S_N1 mechanism. The kinetic solvent isotope effect was normal for such a mechanism. The corresponding value of $\Delta C_p^{\ddagger}$ for the hydrolysis of piperidylsulfamoyl chloride (4) was about the same as found for 2 while the value for the methylethyl isomer (3) was −66 cal deg^{-1} mol^{-1}, an intermediate value supporting an explanation based on solvent exclusion. Experiments in mixed solvents support the hypothesis that solvent reorganization is the major factor in determining the value of $\Delta C_p^{\ddagger}$ for 2 but not for 4. (auth)

38231 ISOTOPE EFFECT ON THE NONRADIATIVE RELAXATION OF ACETONE-^{18}O. Borkman, R. F.; Yamanashi, B. S. (Georgia Inst. of Tech., Atlanta). Chem. Phys. Lett.; 13: No. 6, 592-3(15 Apr 1972).

Phosphorescence lifetimes were measured for acetone and acetone-^{18}O in EPA glass and in the crystalline state both at 77°K. The lifetime of acetone-^{18}O was found to be about 10% longer than that of normal acetone. These results are discussed in terms of theories of electronic relaxation. (auth)

38232 ISOTOPE EFFECT FOR ELECTROMIGRATION OF SODIUM IONS IN MOLTEN SODIUM NITRATE. Saito, Nobufusa; Hirano, Katsumi; Okuyama, Kohei; Okada, Isao (Tokyo Univ.). Z. Naturforsch.; 27a: No. 2, 288-93(Feb 1972).

The relative difference (Δb/b) between the internal electromigration mobilities of ^{22}Na and ^{24}Na in molten $NaNO_3$ was measured in the range 340 to 515°C. The internal mass effect, $\mu_{int} = (\Delta b/b)/(\Delta m/m)$ is −0.056 at 340°C (melting point 308°C), −0.079 at 435°C and −0.068 at 515°C. The errors in μ_{int} are ±0.002. (auth)

38233 VIBRATIONAL ENERGY TRANSFER AND DE-EXCITATION IN THE HF, DF, HF–CO_2, AND DF–CO_2 SYSTEMS. Stephens, Ronald R.; Cool, Terrill A. (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys.; 56: No. 12, 5863-78(15 Jun 1972).

The laser excited fluorescence method was employed to determine the key rate constants for energy transfer and deactivation processes in the HF, DF, HF−CO_2, and DF−CO_2 chemical laser systems at a temperature of 350°K. The self-deactivation rates for HF(v = 1) and DF(v = 1) molecules by ground state molecules were found to be $k_{HF-HF} = 5.25 \pm 0.30 \times 10^4$ $sec^{-1} \cdot torr^{-1}$ and $k_{DF-DF} = 2.0 \pm 0.2 \times 10^4$ $sec^{-1} \cdot torr^{-1}$, respectively. The measured rates of V → V transfer from HF(v = 1) and DF(v = 1) to the CO_2(00°1) state were $k_{HF-CO_2} = 3.7 \pm 0.3 \times 10^4$ $sec^{-1} \cdot torr^{-1}$ and $k_{DF-CO_2} = 17.5 \pm 2.5 \times 10^4$ $sec^{-1} \cdot torr^{-1}$. The respective deactivation rates of CO_2(00°1) by ground state HF and DF were determined to be $k_{CO_2-HF} = 3.6 \pm 0.3 \times 10^4$ $sec^{-1} \cdot torr^{-1}$ and $k_{CO_2-DF} = 1.9 \pm 0.4 \times 10^4$ $sec^{-1} \cdot torr^{-1}$. The large rates for these processes can be attributed to energy transfer to rotation under the influence of a sizable attractive (hydrogen bonded) intermolecular potential well and enhanced repulsion at close range. (auth)

38234 ARGON MATRIX RAMAN SPECTRA OF OXYGEN DIFLUORIDE AND THE OXYGEN FLUORIDE FREE RADICAL. Andrews, Lester (Univ. of Virginia, Charlottesville). J. Chem. Phys.; 57: No. 1, 51-5(1 Jul 1972).

The argon matrix Raman spectra of oxygen difluoride and oxygen-18 difluoride at 16°K were observed; frequencies within one wavenumber of analogous infrared studies were measured. Laser photodetachment of fluorine atoms provided significant yields of the OF and ^{18}OF free radicals; the Raman observations confirmed the earlier infrared work. Temperature cycling operations and depolarization ratio measurements provide aid in identifying new chemical species and making vibrational assignments. (auth)

Isotope Exchange and Isotope Separation

38235 ISOTOPIC EXCHANGE REACTIONS BY MEANS OF ELECTRON TRANSFER. Cecal, Al. (Al. I. Cuza Univ., Iasi). Stud. Cercet. Chim.; 20: No. 1, 31-50(Jan 1972). (In Rumanian).

Isotopic exchange is defined as a process that causes the redistribution of isotopic ions between various chemical forms, various phases or within the molecule, without inducing chemical or physicochemical modifications in the system. The isotopic exchange reactions are used for studying reaction mechanisms, chemical bonds, molecular structure, crystal surfaces, diffusion coefficients, etc. Isotopic exchange by electron transfer relates to elementary processes that take place under participation of the reactants with their environment, as represented by solvent and ligand molecules. The most important theories concerning this process on the basis of kinetic, energetic, and quantum-mechanical concepts are reviewed, in order to obtain a theoretical basis for these reactions. It was concluded that all these specialized theories made contributions to the understanding of the processes but they cannot account for all of the observed phenomena. (Review article, 34 references). (TTT)

38236 THERMODYNAMIC CONSIDERATIONS CONCERNING ISOTOPIC EXCHANGE REACTIONS. Cecal, Al. (Al. I. Cuza Univ., Iasi). Stud. Cercet. Chim.; 20: No. 2, 197-218(Feb 1972). (In Rumanian).

As in any other spontaneous process, isotopic exchange takes place in the direction that leads to the reduction of the free energy of the system, requiring a decrease of enthalpy or increase of entropy. As the former does not depend on the distribution of isotopes involved in the process, entropy is the main thermodynamic driving force of exchange reactions. As the isotopes are redistributed, the entropy changes, reaching a maximum at the equilibrium state. Calculation of the equilibrium constant is outlined and the thermodynamic functions that characterize the isotopic exchange reactions were derived. The electron transfer reactions were assumed to take place by the intermediary of an activated complex in two states. The data indicate that the free energy of activation, ΔF, has a somewhat higher value for small ions, as compared with larger ones; this may be due to the fact that the smaller ones are more strongly hydrated and require more energy to reorient the solvent molecules in the activated complex state than the larger ones. The thermodynamic functions could be calculated only with an approximate precision; no generally applicable theoretical treatment is as yet available. (Review article, 31 references). (TTT)

38237 AB INITIO CALCULATIONS ON THE $H_2 + D_2 \rightarrow 2HD$ FOUR-CENTER EXCHANGE REACTION. II. ORBITALS, CONTRAGRADIENCE, AND THE REACTION SURFACE. Wilson, C. Woodrow Jr.; Goddard III, William A. California Inst. of Tech., Pasadena). J. Chem. Phys.; 56: No. 12, 5913-20(15 Jun 1972).

The reaction surface for the four-center exchange reaction $H_2 + D_2 \rightarrow 2HD$ is discussed in terms of the orbitals from spin-coupling optimized GI(SOGI) calculations. The surface is comparable to previously published surfaces determined by configuration interaction. The shape of the surface is discussed in terms of the exchange kinetic energy and contragradience, which were previously used to discuss the bonding or nonbonding of molecules. (auth)

38238 KINETIC STUDY OF THE OXYGEN EXCHANGE OF SODIUM BICARBONATE AND CARBONATOPENTAAMMINECOBALT(III). Francis, D. J.; Jordan, R. B. (Univ. of Alberta, Edmonton). Inorg. Chem.; 11: No. 6, 1170-3(Jun 1972).

The kinetics of oxygen-18 exchange between water and the carbonate species obtained by dissolving $NaHCO_3$ in water and by dissolving $(NH_3)_5CoCO_3^+$ in water were measured. Both systems were studied in the pH range 7.2 to 8.5 at 20, 26, and 30°C at an ionic strength of 1M ($NaClO_4$). The results of this study confirm a previous proposal that the rate of exchange in the complexed system is controlled by the hydration rate of carbon dioxide. (auth)

38239 RADIOCHEMICAL STUDY OF SELF DIFFUSION AND ISOTOPE EXCHANGE IN AQUEOUS SOLUTIONS. PART VII. ELECTROLYTIC INVESTIGATION OF ISOTOPE EXCHANGE WITHOUT ANALYTICAL SEPARATION OF THE COMPONENTS BY STATIONARY AND ROTATING ELECTRODES. Gosman, Alexandr; Sedlacek, Josef (Technical Univ., Prague). Z. Phys. Chem. (Leipzig); 249: No. 3-4, 161-76(1972).

Some results of isotope exchange investigation in the system $Tl(I)-Tl(III)-HClO_4$ by simultaneous electrodeposition of both components on a single electrode (stationary and rotating) are presented. (auth)

Feed Materials Processing

Refer also to abstracts 38157 and 38407.

Radiation Chemistry

Refer also to abstract 38306.

38240 (LS-245) SELECTIVE BIBLIOGRAPHY ON THE EFFECTS OF IONIZING RADIATION ON SYNTHETIC POLYMERS. Friedman, C.; Waldner, G. (Israel Atomic Energy Commission, Tel Aviv). Feb 1972. 69p. Dep. NTIS (U. S. Sales Only).

An up-to-date literature survey of published papers on the influence of β and γ radiation on polymers, particularly polyethylene, polypropylene, and vinyl and acrylic polymers is presented. The abstracts deal mainly with the crosslinking, grafting, curing, and radiation effects induced by ionizing radiation. The survey is based mainly on the following sources: NSA Vols. 16-25 (1962-1971) and CA Vols. 58-73 (1963-1970). (auth)

38241 (RLO-2230-T-2-3) DIFFUSION CONTROLLED REACTIONS AND EXCHANGE REACTIONS IN SOLUTION. Annual Progress Report. Noyes, Richard M. (Oregon Univ., [Eugene]). 26 May 1972. Contract AT(45-1)-2230. 21p. Dep. NTIS.

Rates of polar exchange of isopropyl and tert-butyl iodides with iodine in aprotic solvents having dielectric constants from 1.9 to 65 were determined. Efforts to measure the diffusion coefficient of hydrogen atoms in water for radiation chemistry studies continue to be frustrated. Difficulties may arise because light can dissociate hydrogen peroxide directly to $H_2 + O_2$ as well as producing hydroxyl radicals. The detailed chemical mechanism by which oscillations occur in the oxidizing power of a solution containing sulfuric acid, potassium bromate, malonic acid, and cerium ions was elucidated. (M.C.G.)

38242 (RT/BIO-(72)29) THERMOLUMINESCENCE STUDIES OF X-RAY IRRADIATED OLEIC ACID, GLYCEROL, AND TRIOLEIN. Caserta, G.; Cervigni, T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 15 Mar 1972. 23p. Dep. NTIS (U. S. Sales Only).

The distribution of metastable energy states in oleic acid, glycerol, and their esterification product, triolein, irradiated at low temperature with x rays, is analyzed by means of thermoluminescence measurements. The metastable energy states are interpreted as low-temperature electron trapping sites that have a well defined activation energy for electron detrapping. In oleic acid four groups of traps with activation energies equal to 0.068, 0.102, 0.158, and 0.209 eV were disclosed. Glycerol, which displays a very weak light emission, also contains discrete sets of traps up to about 0.1 eV. Triolein, on the contrary, shows an exponential distribution of trapping centers from 0.1 to 1.2 eV. The light spectrum is nearly of the same type for the three substances, and is essentially composed of two wavelengths: 3750 and 4800 Å. The possible role of the double bonds in the luminescence processes is outlined. (auth)

38243 REACTIONS OF ELECTRONS IN GLYCEROL. Kajiwara, Takashi; Thomas, J. K. (Univ. of Notre Dame, Ind.). J Phys. Chem.; 76: No. 12, 1700-6(8 Jun 1972).

Nanosecond pulse radiolysis and laser photolysis techniques were used to study the spectral and kinetic properties of electrons in glycerol. The spectra of solvated electrons show a blue shift with decreasing temperature although a time-dependent spectral shift due to relaxation of the solvent around the electron is not observed as in simpler alcohols. Solutes that react with $k \simeq 10^{10}$ M^{-1} sec^{-1} with e_s^- in simple alcohols or water react much more slowly ($\sim\frac{1}{40}\times$) with e_s^- in glycerol. Decreasing the viscosity of glycerol by addition of water increases the rate constant. The data show that increasing viscosity dramatically reduces the mobility of e_s^- although the correlation is not linear. At high concentrations of acetone the yield of e_s^- is reduced, due to scavenging of the precursor of e_s^- by the solute. There is little effect of temperature from +32 to −197°C on this process. Cadmium ions also show this effect, while at the same time Cd^+ is produced. A discussion of the above data is presented. (auth)

38244 ELECTRON SPIN RESONANCE STUDIES OF INORGANIC RADICALS IN IRRADIATED AQUEOUS SOLUTIONS. I. DIRECT OBSERVATION. Behar, D.; Fessenden, Richard W. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 12, 1706-10(8 Jun 1972).

A search was carried out for the ESR spectra of radical intermediates present during steady-state, in situ radiolysis of aqueous solutions of inorganic salts. The technique used is capable of detecting radicals that react by diffusion-controlled recombination if the ESR line widths are small (<1 G). Out of 15 systems studied, four gave detectable ESR signals. The ESR lines of the radicals formed in the other systems may be broad. The radicals successfully studied are $\cdot SO_3^-$ (from OH + SO_3^{2-}, g = 2.00306), $\cdot PO_3^{2-}$ (from OH + HPO_3^{2-}, a^P = 567.6 G, g = 2.00154), $\cdot HPO_2^-$ (from OH + $H_2PO_2^-$, a^P = 480.4, a^H = 89.7 G, g = 2.00293), and $\cdot CS_2^-$ (from e_{aq}^- + CS_2, g = 2.00804). No ESR lines were detected from solutions of HCO_2^-, CO_3^{2-}, S^{2-}, Se^{2-}, SeO_3^{2-}, Br^-, I^-, SCN^-, OCN^-, N_3^-, HO_2^-, NO_2^-, NH_2OH, or AsO_2^-. Steady-state measurements of radical concentrations were used to determine rates of radical recombination for the species $\cdot SO_3^-$, $\cdot PO_3^{2-}$, and $\cdot HPO_2^-$. (auth)

38245 ELECTRON SPIN RESONANCE STUDIES OF INORGANIC RADICALS IN IRRADIATED AQUEOUS SOLUTIONS. II. RADICAL TRAPPING WITH NITROMETHANE. Behar, D.; Fessenden, Richard W. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 12, 1710-21(8 Jun 1972).

Radical trapping in the aci anion of nitromethane ($CH_2{=}NO_2^-$) was used in a study of the intermediates in irradiated aqueous solutions of a number of inorganic salts. Steady-state, in situ radiolysis was carried out with a 2.8-MeV electron beam. Two types of reactions with this reagent were observed: direct addition of the inorganic radical (X·) to the CN double bond to form the adduct $XCH_2NO_2^-$ and an electron transfer from $CH_2{=}NO_2^-$ to X·, which results in the formation of $\cdot CH_2NO_2$ (which in turn reacts with another nitromethane molecule to form $O_2NCH_2CH_2NO_2^-$). Variation of the nitrogen and methylene proton hyperfine constants of the adduct radicals, $XCH_2NO_2^-$, is sufficient that a number of different spectra could be distinguished. In some cases hyperfine splittings by magnetic nuclei in the substituent X were also observed (e.g., where X· was CN· or HPO_2^-). The radicals were identified by reference to the expected radiation chemistry of the inorganic solute. Accurate spectral parameters are given for 14 adducts to $CH_2{=}NO_2^-$. The successful application of $CH_2{=}NO_2^-$ as a radical trap in these various cases demonstrates the potential for general use both in other studies of these same radicals and in studies of other radicals both inorganic and organic. The results contribute to the understanding of the radiation chemistry of a number of these inorganic systems. Of particular importance is the demonstration of the reaction $e_{aq}^- + S_2O_3^{2-} \rightarrow \cdot S^- + SO_3^{2-}$. (auth)

38246 ELECTRON SPIN RESONANCE STUDIES ON IRRADIATED HETEROGENEOUS SYSTEMS. VIII. RADICAL CATION FORMATION FROM TOLUENE. Komatsu, T.; Lund, A.; Kinell, P.-O. (Swedish Research Councils' Lab., Studsvik). J. Phys. Chem.; 76: No. 12, 1721-6(8 Jun 1972).

An investigation was initiated to resolve the question of whether positive or negative ions are formed from aromatic compounds irradiated in the adsorbed state. The predominant formation of molecular cations in the cases of toluene and toluene-α-d_3 adsorbed on silica gel and Vycor glass was demonstrated unambiguously by means of ESR spectroscopy. Benzyl and tolyl radicals gave spectra that differ significantly from those obtained from this study on toluene. Weak absorptions due to the cyclohexadienyl type of radical could occasionally be detected, but no spectrum attributable to the anion was found. The magnitudes of the isotropic coupling constants $|a_2|$ = 2.1 G, $|a_4|$ = 11.8 G, $|a_{CH_3}|$ = 18 G estimated by line profile simulations are in reasonable accord with theoretical estimates. (auth)

38247 ELECTRON SPIN RESONANCE STUDIES ON IRRADIATED HETEROGENEOUS SYSTEMS. IX. ANISOTROPY OF THE g FACTOR AND THE HYPERFINE COUPLING CONSTANT OF THE BENZENE CATION IN THE ADSORBED STATE. Komatsu, T.; Lund, A. (Swedish Research Councils' Lab., Studsvik). J. Phys. Chem.; 76: No. 12, 1727-8(8 Jun 1972).

The ESR spectrum of the benzene cation formed on the surface of a molecular HY sieve by γ irradiation at 77°K was analyzed. At 203°K the axially symmetric proton couplings $|A_\perp|$ = 4.05 G, $|A_{||}|$ = 5.00 G, and $\Delta g = g_\perp - g_{||} = 1.8 \times 10^{-4}$ afforded a reasonable fit in a line shape simulation with a Lorentzian derivative line width ΔH_{pp} = 0.4 G. A theoretical estimate of the dipolar coupling when rapid rotation takes place about the molecular sixfold axis agrees with the experimental value. At 77°K the line shape cannot be reproduced either with axially symmetric or completely anisotropic couplings indicating that the rotation frequency is comparable to the hyperfine coupling anisotropy. (auth)

38248 RADICAL CATION PRODUCED IN A γ-IRRADIATED SINGLE CRYSTAL OF DL-METHIONINE AS STUDIED BY ELECTRON SPIN RESONANCE AND OPTICAL ABSORPTION SPECTROSCOPY. Kominami, Shiro (Kyoto Univ.). J. Phys. Chem.; 76: No. 12, 1729-33(8 Jun 1972).

A photosensitive paramagnetic species was detected in a single crystal of DL-methionine γ-irradiated at 77°K, which was identified as a radical cation of DL-methionine with a hole in one of the nonbonding orbitals of sulfur, through the combined study of ESR and optical absorption spectroscopy. The electronic structure of the radical cation is discussed in some detail based on the anisotropy in g factor and the optical absorption spectrum. (auth)

38249 REVERSIBLE LINE BROADENING IN THE ELECTRON SPIN RESONANCE SPECTRA OF tert-BUTYL RADICALS IN γ-IRRADIATED CRYSTALLINE tert-BUTYL ISOTHIOCYANATE. Chung, Yoon Jin; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Phys. Chem.; 76: No. 12, 1792-4(8 Jun 1972). (ORO-2968-73).

Reversible ESR line broadening in γ-irradiated crystalline tert-butyl isothiocyanate is reported. The results distinguish clearly between the two states of the radical—anion pair and the radical anion. (M.C.G.)

38250 TRAPPED ELECTRONS AND RADICALS IN γ-IRRADIATED PROPYLENE CARBONATE GLASSES. Shaede, Eric A. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 50: No. 6, 728-91(15 Mar 1972).

Radicals formed by γ-irradiation of propylene carbonate (PC) glasses at 77°K were studied by ESR and optical spectroscopy. Trapped electrons were identified by their narrow (ΔH_{ms} = 4.5 G) Gaussian ESR line at g = 2.0028, which was completely resolved from the radical spectrum. The trapped electrons were unstable at 77°K. They decayed fairly rapidly via a process exhibiting nonhomogeneous kinetics believed to be reaction with positive ions. The temperature dependence of the ESR spectra of the other radicals formed is discussed although conclusive assignment of the lines could not be made. Ultraviolet photolysis of the radicals in the irradiated PC glasses produced new species identified as HCO, CO_3^-, and CH_3 by their characteristic ESR spectra. In addition, a complex optical absorption band in the 500 to 750 nm region was assigned to a combination of the absorption bands of the CO_3^- radical anion and the HCO radical. (auth)

38251 NANOSECOND PULSE RADIOLYSIS OF METHANOLIC AND AQUEOUS SOLUTIONS OF READILY OXIDIZABLE SOLUTES. Ellison, D. H.; Salmon, G. A.; Wilkinson, F. (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A; 328: No. 1572, 23-36(2 May 1972).

The formation of I_2^- and $(CNS)_2^-$ was observed in aqueous solution of KI and KCNS respectively, following irradiation with nsec pulses of 3-MeV electrons. In both cases it is necessary to invoke the intermediate and consecutive formation of two species that do not absorb light at the monitoring wavelength. A mechanism is suggested for the formation of X_2^- (where $X^- = I^-$ or CNS^-). Rate constants were evaluated for the formation of I_2^- (k = 1.21 ± 0.08 × 10^{10} l mol^{-1} sec^{-1}) and for $(CNS)_2^-$ (k = 1.08 ± 0.10 × 10^{10} l mol^{-1} sec^{-1}). $HOCNS^-$ is estimated to have a lifetime of about 5 ns. The radiation-induced oxidation of N,N,N′,N′-tetramethyl-p-phenylenediamine (TMPD) to Wurster's Blue cation ($TMPD^+$) was observed by nsec pulse radiolysis of solutions of TMPD in methanol. It was concluded that the oxidation of TMPD is by methoxy radicals and the rate constants $k_{CH_3O\cdot+TMPD}$ and $k_{CH_3O\cdot+CH_3OH}$ are evaluated to be (6.10 ± 0.05) × 10^9 mol^{-1} s^{-1} and 2.63 ± 0.10 × 10^5 mol^{-1} s^{-1}, respectively. Thus the half-life of methoxy radicals in pure methanol is 106 ns. The formation of I_2^- was observed in methanolic solutions of KI. The oxidizing species is thought to be the methoxy radical and a mechanism of formation suggested, and rate constants are given. Observations on the transient uv absorption band of pulse-irradiated methanol suggest that the spectra of CH_3O and CH_2OH are very similar for λ = 250 to 320 nm. (auth)

38252 EPR STUDIES OF THE NATURE AND PROPERTIES OF THE PARAMAGNETIC CENTRES OF γ-IRRADIATED PROTEINS. Sud'bina, E. N.; Pulatova, M. K.; Kayushin, L. P. (Inst. of Biological Physics, Moscow). Biophysics (USSR) (Engl. Transl.); 16: No. 4, 616-23(1971).

Translated from Biofizika; 16: No. 4, 596-602(1971).

Studies were made of the EPR signals of individual paramagnetic centers from the total complex EPR spectrum observed in the following proteins γ-irradiated at a temperature of −196°C: serum albumin, egg albumin, lysozyme, pepsin, trypsin, silk fibroin. On the basis of study of the properties of the paramagnetic centers it was shown that on exposure of proteins to ionizing radiations at a temperature of −196°C the following paramagnetic centers appeared: (1) trapped electrons; (2) anion-radicals with localization of an unpaired electron on the S—S bond; (3) paramagnetic centers with localization of an unpaired electron on the aliphatic amino acid residues; (4) paramagnetic centers appearing on separation of hydrogen atoms from C_α carbon of the peptide chain. At room temperature paramagnetic centers were observed with localization of an unpaired electron on the oxygen atom of the hydrogen bond and the paramagnetic centers RS˙. (UK)

38253 INFLUENCE OF THE CYCLIC STRUCTURE OF HYDROCARBONS ON RADIATION PROTECTION. Foeldiak, G.; Wojnarovits, L. (Inst. of Isotopes, Budapest). Int. J. Radiat. Phys. Chem.; 4: No. 2, 189-97(May 1972).

The $G(H_2)$-values of mixtures containing C_5-C_8 aliphatic normal or cyclic alkanes and monoalkenes with equal number of carbon atoms and the $G(H_2)$ values of the pure components were determined at 35 ± 3°C using a dose of 4.4 Mrad provided by a ^{60}Co source of 80 kCi activity. The behavior of cyclic saturated and unsaturated hydrocarbons in radiation chemical processes differs in many respects from that of the straight-chain alkanes and alkenes. For example, the $G(H_2)$ values of straight-chain alkenes slightly increase with increasing number of carbon atoms; in the case of C_5-C_8 cycloalkenes, however, these values decrease in the order cyclopentene ≥ cyclohexene > cycloheptene > cyclooctene. The extent of the "protecting effect" in the saturated-unsaturated hydrocarbon mixtures is estimated from the ratio of the $G(H_2)$-value calculated on the basis of the linear mixing rule of a mixture to that obtained by measurement. The extent of the protecting effect of a given unsaturated hydrocarbon is greater when it is mixed with a normal than with a cyclic hydrocarbon having the same number of carbon atoms. The explanation suggested is that the strained structures of cycloalkanes make them more likely than straight-chain hydrocarbons to employ the energy supplied by irradiation for fast chemical decomposition, and thus the possibility of energy and charge transfer reactions taking place is reduced (i.e., the reactions become proportionately less important). There seems to be a definite relationship between the $G(H_2)$ values of mixtures of normal alkane with terminal normal alkene mixtures and of pure terminal normal monoalkenes and the number of double bonds per unit mass of the irradiated sample. (auth)

38254 GAMMA RADIOLYSIS OF IONIC LIQUIDS. I. THE DECOMPOSITION MECHANISM OF MOLTEN ALKALINE AND SILVER NITRATES. Kalecinski, J. (Inst. for Low Temperature and Structure Research, Wroclaw). Int. J. Radiat. Phys. Chem.; 4: No. 2, 171-9(May 1972).

The radiation decomposition of molten nitrates of sodium, potassium and silver, both pure and containing low concentrations of KBr and KI, was examined. The yields $G(O_2)$ and $G(NO_2^-)$ decreased with increase of KBr and KI concentration. The mechanism of decomposition in which the intermediate atomic oxygen plays an important role was established. On this basis the equations for the yields were derived in good agreement with all experimental data. (auth)

38255 RADIATION-INDUCED REDUCTION OF Fe(III)–EDTA. Bhattacharyya, S. N.; Kundu, K. P. (Saha Inst. of Nuclear Physics, Calcutta). Int. J. Radiat. Phys. Chem.; 4: No. 2, 253-4(May 1972).

The radiolytic reduction of Fe^{III}–EDTA induced by OH radical attack in aerated aqueous solutions is discussed and compared with the results observed earlier by Broszkiewicz (Int. J. Radiat. Phys. Chem., 4: 117(1972)) on the effect of several organic additives on the radioinduced reduction of Fe^{3+} in aqueous solution. It was argued that the radical formed through OH radical attack at the ligand does not form peroxide in the presence of oxygen, but the odd electron at the ligand site is readily transferred to the central metal ion of the metal chelate in question. (auth)

38256 NONHOMOGENEOUS KINETICS IN IRRADIATED LIQUIDS. Freeman, Gordon R. (Univ. of Alberta, Edmonton). Int. J. Radiat. Phys. Chem.; 4: No. 2, 237-48(May 1972).

The "diffusion" kinetics and "coulombic interaction" models for the nonhomogeneous kinetics of reactions in irradiated liquids are contrasted. The coulombic interaction model is then discussed; parts of it are clarified. It is demonstrated that calculated scavenging yields are affected by the form of the ion–electron separation distribution that is assumed. The scavenging yields calculated from previously published coulombic interaction models are not improved by insertion of the prescribed diffusion approximation into the model. Comments on this paper by Burns (Atomic Energy Establishment, Harwell) are given. (UK)

38257 RADIOLYSIS OF AQUEOUS SOLUTIONS OF METHYLENE CHLORIDE. Balkas, Turgut I. (Middle East Technical Univ., Ankara. Carnegie-Mellon Univ., Pittsburgh). Int. J. Radiat. Phys. Chem.; 4: No. 2, 199-208(May 1972).

The radiolysis of neutral aqueous solutions of methylene chloride was studied over the concentration range 2 to 200 mol m^{-3} both in the presence and in the absence of hydrogen atom and hydroxyl radical scavengers. In all cases the hydrated electron reacts quantitatively with the methylene chloride, the second-order rate constant of the initial step being $6.3 \pm 0.5 \times 10^9$ dm^{-3} mol^{-1} s^{-1}. In the most dilute solutions with radical scavengers present $G(Cl^-)$ was found to be 2.73 ± 0.07. This yield is interpreted as being very nearly identical to the yield of electrons that escape from the spurs. The observed yield increased with increasing methylene chloride concentration, to 4.1 at 0.2 mol dm^{-3}, as a result of scavenging electrons within the spurs. Yields approximately 0.6 units higher were observed in the absence of scavengers. Pulse conductivity studies on saturated solutions in the presence of H· and OH· scavengers showed a conductivity increase that was complete within 10 μs. The yield of 3.9 found agrees with the steady-state value within experimental error. In the absence of scavengers a similar initial increase was found but the conductivity increased approximately 15% further on the millisecond time scale. While the magnitude of this additional yield is similar to that expected from hydrogen atom attack on the methylene chloride, the rate of this latter reaction is sufficiently high that it should be complete within 100 μs. Thus neither hydrogen atom nor hydroxyl radical attack appears to produce HCl directly and both the additional conductivity observed at long times and the high yields noted above appear to be due to secondary reactions. Hydrolysis of the $\cdot CH_2Cl$ radical produced by the initial reaction of electrons with the methylene chloride appears to be a relatively insignificant process. (auth)

38258 GAMMA RADIOLYSIS OF IONIC LIQUIDS. II. THE FREE VOLUME FACTOR. Kalecinski, J. (Inst. for Low Temperature and Structure Research, Wroclaw). Int. J. Radiat. Phys. Chem.; 4: No. 2, 181-8(May 1972).

It was shown that the free volume is the decisive factor affecting the radiation decomposition yield for molten alkaline nitrates. The temperature dependence for liquids may be connected, therefore, with the temperature change of their free volumes. A general equation for the decomposition yield was derived: $G(prod)^{-1} = a + b \exp(\gamma V_c/V_f)$, where V_f is the free volume, and the other quantities are constants for the same type of liquid. (auth)

38259 ALPHA- AND GAMMA-RADIOLYSIS OF CONCENTRATED LiCl SOLUTIONS. Vladimirova, M. V.; Ryabova, A. A.; Milovanova, A. S. (State Committee for the use of Atomic Energy, Moscow). Int. J. Radiat. Phys. Chem.; 4: No. 2, 149-58(May 1972). (In Russian).

Alpha and γ radiolysis of concentrated hydrochloric acid solutions of LiCl was studied and the yields of H_2 and Cl_2 were determined. $G(Cl_2)$ and $G(H_2)$ were measured in deaerated solutions for various LiCl concentrations, acidities, dose rates, and doses. The chlorine yield in deaerated solutions was shown to be appreciably higher on α than on γ radiolysis. On changing the LiCl concentration from 3.0 to 10 mol dm^{-3} ($[HCl] = 0.1$ mol dm^{-3}) $G(Cl_2)$ varies on α radiolysis from 0.7 to 1.85 molecules/100 eV, and on γ radiolysis from 0.25 to 0.6 molecule/100 eV. In this range of LiCl concentrations the H_2 yields are on α radiolysis 1.70 to 1.85 molecules/100 eV and 0.5 to 0.6 molecule/100 eV on γ radiolysis. These yields were obtained at an α dose rate $I = 10^{16}$ eV/cm^3 min and at a γ dose rate $I = 10^{18}$ eV/cm^3 min. In aerated solutions α-irradiated at the dose rate of 10^{16} eV/cm^3 min $G(Cl_2)_{aerated} = G(Cl_2)_{deaerated}$; for a similar γ dose rate the chlorine yield is actually zero. For a γ dose rate of 10^{18} eV/cm^3 min $G(Cl_2)$ in aerated solutions is very high, e.g. in 10 mol dm^{-3} LiCl solution $G(Cl_2)_{aerated} = 2.75$ molecules/100 eV. The relationship between the chlorine yield and the dose rate leads to the conclusion that the reaction of chlorine with hydrogen peroxide plays a significant role in the mechanism of radiolysis of concentrated chloride solutions of low acidity: $Cl_2 + H_2O_2 = 2H^+ + 2Cl^- + O_2$. The contribution of this reaction is the higher the lower the dose rate (within 10^{15} to 10^{18} eV/cm^3 min) the longer the time of irradiation of the solutions. A variation in acidity of LiCl solution within 0.1 to 1 mol dm^{-3} resulted on α radiolysis in an increase of chlorine yield and did not affect $G(Cl_2)$ on γ radiolysis. The mechanism of α and γ radiolysis of the solutions studied is discussed. (auth)

38260 TRANSIENT CHARGED RADIOLYSIS PRODUCTS OF ORGANIC LIQUIDS STUDIED BY ELECTRICAL AND OPTICAL METHODS. Vannikov, A. V.; Mal'tsev, E. I.; Zolotarevskii, V. I.; Rudnev, A. V. (Inst. of Electrochemistry, Moscow). Int. J. Radiat. Phys. Chem.; 4: No. 2, 135-48(May 1972). (In Russian).

The theory and experimental technique of the transient current curves (T.C.C.) method used simultaneously with the transient absorption spectroscopy in the study of charged particles by pulse irradiation are described. Within the period of $t_0 < \min_K(L^2/D_K)$, $t_0 < \min_K(LL_d kT/D_K|Z_K eV|)$ (L–distance between the electrodes, L_d–Debye shielding radius, V–voltage, D_K, Z_K–diffusion coefficients and valences of the K-type particles) the distribution of the charges throughout the volume can be looked on as homogeneous and the T.C.C. are accounted for by the bulk processes caused by charged particles. The T.C.C. were registered in a cell to which a constant and pulsed voltage was applied. The existence of solvated electrons ($\lambda_{max} = 900$ nm) in methyl ethyl ketone (MEK) was proved by radiolysis of this liquid (pure and in the presence of anthracene or oxygen) using electrical and optical methods of detection. The reaction rate constants of the corresponding processes were determined. The parallel T.C.C. and transient spectrum investigations prove that the e_s disappears in hexamethylphosphoramide (HMPA), alcohols, and amines in reactions with molecules of liquid or with traces of impurities. The mobilities of the e_s, negatively charged molecules of oxygen, and transient ion-molecules were determined. In HMPA, MEK, n-butylalcohol, isoamylalcohol, monobutylamine, and tributylamine the mobilities of the e_s are: 5.5×10^{-4}; 1.5×10^{-3}; 7.5×10^{-4}; 9.5×10^{-4}; 2.7×10^{-3}; 2×10^{-3} $cm^2V\ s^{-1}$ respectively. The radiation yields obtained for these liquids are: 1.2, 0.84, 0.58, 0.40, 0.27 and 0.25 molecules per 100 eV. The results obtained are discussed in terms of a radiolysis model involving ion pairs. (auth)

38261 ELECTRON SPIN RESONANCE SPECTRA OF ALIPHATIC FLUOROALKYL RADICALS IN POLYCRYSTALLINE STATE. I. GAMMA RADIOLYSIS OF PERFLUORO ACIDS. Mach, K. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun.; 37: No. 3, 663-78(Mar 1972).

A high number of fluoro radicals of the $R\dot{C}F_2$ and $R\dot{C}FR'$ types (R = fluoroalkyl, R′ = carboxyl), formed by the γ-radiolysis of perfluoro acids, their aqueous solutions, and sodium salts at 77°K and by subsequent heating, was used to show that the method of radical identification, determining the number of F_α atoms from the total width of the spectrum, is general and that the sufficient homogeneity of the polycrystalline samples is the only condition for its application. In the γ irradiation of aqueous solutions of these acids at 77°K only $R\dot{C}F_2$ radicals are formed; in pure acids the mixture of both $R\dot{C}F_2$ and $R\dot{C}FR'$ radicals is formed while in salts the radicals $R\dot{C}FR'$ are formed predominantly. If heated, the radicals $R\dot{C}F_2$ disappear and give rise to radicals $R\dot{C}FR'$. The structural variety appearing in wings of the spectra indicates that the wing structures, the separation of which determines $A_{max}^{F\alpha}$, reflect the interaction of F_β nuclei of the radicals as it would manifest itself in single crystal at its orientation in the magnetic field giving $A_{max}^{F\alpha}$. A relatively frequent doublet structure in wings of the spectra with different separation of doublet peaks shows that one F_β atom causes zero splitting whereas the second F_β atom gives rise to splitting varying from values close to zero up to 94 G. Reversible and irreversible changes of both $A_{max}^{F\alpha}$ and $a^{F\beta}$ were observed in $R\dot{C}FR'$ radicals at various temperatures as a consequence of changes in planarity of radicals and in configuration of the F_β atoms with respect to unpaired electron orbital. (auth)

38262 RADIATION-INDUCED BINDING OF CYSTEINE AND CYSTINE WITH AROMATIC AMINO ACIDS OR SERUM ALBUMIN IN AQUEOUS SOLUTION. Yamamoto, Osamu (Hiroshima Univ.). Int. J. Radiat. Phys. Chem.; 4: No. 2, 227-36(May 1972).

It was confirmed that ionizing radiation causes cysteine and cystine to bind with protein and aromatic amino acids (trytophan and phenylalanine) in aqueous solution. Oxygen was the only scavenger used which could prevent the binding. In addition, the oxidized substances, cystine disulfoxide and cysteic acid, no longer have this binding activity. (auth)

38263 EVIDENCE THAT $e^-_{aq} + H_3O^+_{aq}$ DOES GIVE H ATOMS. Neta, P.; Fessenden, R. W.; Schuler, R. H. (Carnegie-Mellon Univ., Pittsburgh). Nature (London) Phys. Sci., 237: No. 72, 46-7(15 May 1972).

Reference is made to Kongshaug, Steen and Cercek (Nature Phys. Sci., 234: 97(1971)) who reported alleged evidence that $e^-_{aq} + H_3O^+_{aq}$ does not give H atoms and that the major fraction of the residual hydrogen from γ-radiolysis of water does not consist of H atoms. This evidence is questioned and ESR evidence given that H atoms are produced both directly by the radiolysis of water and from the reaction of e^-_{aq} with acids. A reply of Kongshaug, Steen and Cercek is appended, who state that the conclusions reached from the ESR experiments disregard any short-lived radiolytic intermediates, and it is the decay of these radicals, and not $e^-_{aq} + H_3O^+_{aq}$, that yields H atoms. (UK)

38264 TEMPERATURE DEPENDENCE OF THE RADIOLYSIS OF AQUEOUS SOLUTIONS. I. METHANOL. Afanas'ev, A. M.; Byakov, V. M.; Kalyazin, E. P. (Moscow State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 445-7(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 501-4(Nov-Dec 1971).

The temperature dependence of γ radiolysis of a deaerated 3M aqueous methanol solution was studied. As the temperature was raised from 30 to 350°C, the yield of formaldehyde diminished, whereas that of ethylene glycol increased. The combined yield of both products remains constant at ~3 molecules/100 eV. By the method of stationary concentration it was found that for methanol concentrations greater than 0.5M, the following relations are satisfied: $G(CH_2OH)_2 = \frac{1}{2}\ (Ge_{aq} + G_H + G_{OH})$ and $G(CH_2O) = G_{H_2O_2}$. (auth)

38265 RADIOLYSIS OF LIQUID m-XYLIDINE. Petrukhin, N. V.; Kamenetskaya, S. A. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 448-51(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 505-8(Nov-Dec 1971).

The radiation decomposition of m-xylidine in the liquid phase by γ radiation in doses of 5 to 250 Mrad and with radiation intensities of 300 to 1300 rad/sec was investigated. The principal radiolysis products of m-xylidine are hydrogen and hydrazoxylene. The probable mechanism of the formation of the radiolysis products is discussed and their radiation yields were determined. (auth)

38266 ROLE OF CHARGES IN RADIOCHEMICAL CHANGES IN RUBBER. Bol'shakova, S. I.; Kuz'minskii, A. S. (Scientific-Research Inst. of the Rubber Industry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 452-6(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 509-14(Nov-Dec 1971).

The influence of the nature of paramagnetic centers stabilized in an irradiated rubber matrix on the chemical conversions of rubbers was studied. Cis-polybutadiene and a copolymer of butadiene with acrylonitrile, into which charge-accepting additives were introduced, were selected for the investigation. In rubbers irradiated at 77°K, together with rubber radicals, stabilized electrons and ion radicals of the additives were observed. It was found that additions of acceptors of ions, while not changing the total number of stabilized paramagnetic centers, determine the chemical changes in the rubber as a result of radiolysis. Thus, an electron acceptor and a combination of electron donor and acceptor additives sensitize the formation of intermolecular bonds in rubbers, while an electron donor protects the rubber from radiation influence. Evidently the sensitization of crosslinking when an electron is captured by a molecule of an additive occurs as a result of an ionic-molecular reaction with the participation of the double bonds of the rubber molecule. (auth)

38267 INDIVIDUAL COMPONENTS OF ABSORPTION SPECTRA ARISING UPON IMPULSE IRRADIATION OF HYDROCARBONS SATURATED WITH OXYGEN. Zimina, G. M.; Bakh, N. A. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 457-60(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 515-18(Nov-Dec 1971).

Short-lived absorption spectra arising on impulse irradiation with electrons of n-heptane, isooctane, isopentane, and 1-heptene in the presence of molecular oxygen were investigated. It was shown that the complex asymmetric absorption spectrum $D = f(\nu)$ can be separated into individual components obeying a Gaussian distribution. Three components appear in saturated hydrocarbons having normal and isostructures: λ_{max} 270, 286, and 252 nm; two components appear in an olefin (1-heptene): $\lambda_{max} = 270$ and 288 nm. The component having $\lambda_{max} = 270$ nm belongs to, as was established earlier, the peroxy radical $\dot{R}O_2$. Radiation yields and recombination rate constants of this radical were determined. (auth)

38268 EFFECT OF A SULFUR HETEROATOM ON THE RADIATION YIELDS OF HYDROGEN IN THE RADIOLYSIS OF NORMAL DIALKYL SULFIDES AND MIXTURES OF THE LATTER WITH CERTAIN ALKANES IN THE LIQUID PHASE. Strunin, V. P., Bol'shakov, B. V. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 479-80(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 540-1(Nov-Dec 1971).

The compounds were irradiated by fast electrons at an average dose rate of 1 Mrad/min. The yield of hydrogen from the dialkyl sulfides was compared with the yield from hexane. Yields of hydrogen from mixtures of dialkyl sulfides and alkanes were measured also. The hydrogen yield was, to a satisfactory approximation, a single-valued function of the electronic fraction of sulfur. The sulfur heteroatom protects all C−H bonds in its vicinity to about the same extent. (M.C.G.)

38269 ACCUMULATION OF NITRITE IONS DURING γ AND UV IRRADIATION OF CONCENTRATED SODIUM NITRATE SOLU-

TIONS. Podzorova, E. A.; Orekhov, V. D.; Vereshchinskii, I. V.; Kabakchi, A. M. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 481-2(Nov–Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 542-4(Nov–Dec 1971).

Acetic acid solutions of sodium nitrate were irradiated with uv and γ radiations and accumulation of nitrite ions was measured. Neither successive irradiations nor simultaneous irradiation showed nonadditive accumulations. (M.C.G.)

38270 INFLUENCE OF PRELIMINARY THERMOVACUUM TREATMENT CONDITIONS ON RADIATION YIELD OF SULFUR FROM CADMIUM SULFIDE DURING γ-RADIOLYSIS. Kolbanovskii, Yu. A.; Mannanova, Kh. Kh.; Niyazov, Kh. R. (Inst. of Nuclear Physics, Tashkent). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 483-4(Nov–Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 544-5(Nov–Dec 1971).

The influence of regimes for preliminary thermovacuum treatment and preliminary γ–neutron irradiation on the sulfur yield during γ radiolysis of CdS was studied. Both preliminary reactor radiation and severe prolonged thermovacuum treatment led to an increase in the radiation yield of sulfur. (M.C.G.)

38271 FORMATION OF RADICALS IN THE RADIOLYSIS OF BUTADIENE–ACRYLONITRILE COPOLYMERS OF DIFFERENT MICROSTRUCTURE. Kozlov, V. T.; Pashinin, V. I.; Evseev, A. G.; Kashevskaya, N. G. (Scientific-Research Inst. of the Rubber Industry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 491-2(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 549-50(Nov-Dec 1971).

The influence of various structure elements on the process of free radical formation during low-temperature γ radiolysis of elastomers was studied. (M.C.G.)

38272 RADIOLYSIS OF SOLUTIONS OF NITROGEN DIOXIDE IN OCTANE. Egorov, G. F.; Medvedovskii, V. I.; Pyatibratov, Yu. P. (Inst. of Electrochemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 495-6(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 551-3(Nov-Dec 1971).

The composition was studied and yields determined for γ radiolysis of NO_2 in octane. The main gaseous products are H_2 and N_2. Trace amounts of CH_4, C_2H_6, C_3Hg, and nitrous oxide were also found. The hydrogen yields did not depend on NO_2 concentration. (M.C.G.)

38273 RADIATION CHEMICAL PROCESSES IN POLYVINYL ALCOHOL AT LOW TEMPERATURE. Faizi, N. Kh.; Il'icheva, Z. F.; Slovokhotova, N. A. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 497-8(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 553-4(Nov-Dec 1971).

Infrared and electronic absorption spectra of films of poly(vinyl alcohol) irradiated under vacuum at 77°K and room temperature by γ radiation and fast electrons were obtained. Mechanisms of the radiolysis were determined. (M.C.G.)

38274 STUDY OF RADICAL REACTIONS IN THE RADIOLYSIS OF HYDROCARBONS. Pichuzhkin, V. I.; Arshakuni, A. A.; Saraeva, V. V. (Moscow State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 499-500(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 554-6(Nov-Dec 1971).

Reactions of radicals generated in radiolysis of hydrocarbons were studied using solutions of 1-chloroheptane in hexane. (M.C.G.)

38275 RADIATIVE-CHEMICAL SYNTHESIS OF CHLOROETHYLDICHLOROPHOSPHINE FROM PCl_3 AND ETHYLENE. Zagorets, P. A.; Shostenko, A. G.; Dodonov, A. M. (Moscow Chemotechnological Inst.). High Energy Chem. (USSR) (Engl. Transl.); 5: No. 6, 501-2(Nov-Dec 1971).

Translated from Khim. Vys. Energ.; 5: No. 6, 556-7(Nov-Dec 1971).

Mixtures of PCl_3 and ethylene were irradiated by γ radiation and the effects of temperature and pressure on the reaction studied. The kinetics of concentration of chloroethyldichlorophosphine (chloroethylphosphorous dichloride) were determined. The yield of this compound increased with temperature and with decreasing dose. (M.C.G.)

38276 NANOSECOND PULSE RADIOLYSIS TECHNIQUES FOR THE STUDY OF LIQUIDS USING A 600 kV FEBETRON. Kenney-Wallace, G. A.; Shaede, E. A.; Walker, D. C.; Wallace, S. C. (Univ. of British Columbia, Vancouver). Int. J. Radiat. Phys. Chem.; 4: No. 2, 209-25(May 1972).

Some of the ways in which a 600-kV Febetron electron accelerator was adapted to nanosecond pulse radiolysis studies of liquids are outlined under four categories: (1) emission spectroscopy during the pulse and when the medium shows strong self-absorption of its own fluorescence, (2) instantaneous absorption spectroscopy using an internal Cherenkov light source; this was demonstrated by spectrographic and spectrophotometric methods and the sensitivity is such that strongly absorbing species ($e \approx 10^3$ m^2mol^{-1}) having lifetimes as short as 3×10^{-11} s may be detected (for instance e^-_{aq} in 2 mol dm^{-3} H^+ solution), (3) very fast kinetic studies using laser photometry for monitoring purposes and utilizing the maximum dose-rates (3×10^{14} rad s^{-1}), (4) a combined flash photolysis-pulse radiolysis arrangement in which part of the electron beam is used for radiolysis and the rest to stimulate a nanosecond light flash in a silvered hemispherical scintillator surrounding the irradiation cell. Advantages of the very intense and short electron pulse are discussed together with the problems associated with weak penetration of 600-kV electrons. Some experimental details are given including methods of dosimetry. (auth)

38277 GENERAL TECHNIQUE FOR THE SPECTROSCOPY OF TRANSIENT ABSORBING SPECIES. Aldrich, John E.; Foldvary, Peter; Hunt, John W.; Taylor, William B.; Wolff, Ronald K. (Univ. of Toronto). Rev. Sci. Instrum.; 43: No. 7, 991-5(Jul 1972).

A convenient routine method for the study of spectra of transient absorbing species produced by radiation is described. The specific example discussed in detail is an addition to the stroboscopic pulse radiolysis system to allow determination of the spectra of transient species after 30 psec or after several nanoseconds. New electronic circuits were designed to increase the sensitivity and linearity of the detection system. The electronic systems were carefully evaluated, and the over-all performance of the system is shown by a sample spectrum of the hydrated electron. (auth)

38278 RADIOLYSIS OF IODINE SOLUTIONS IN TRIBUTYL PHOSPHATE. Zagorets, P. A.; Raskina, Z. I.; Bulgakova, G. P.; Makarov, V. M. At. Energ. (USSR); 32: No. 5, 422-4 (May 1972). (In Russian).

A spectrophotometric study was made between 210 and 600 nm of the chemical forms of iodine formed in TBP solution during irradiation by a ^{60}Co source to yield a dose rate of 2.8×10^{15} eV/ml · sec. In the absence of radiation, the concentration of I_3^- was small, but this species accumulated rapidly during irradiation, and was destroyed by excessive doses, probably through the presence of radiolysis products of TBP. (K.S.W.)

38279 EARLY STAGES IN THE RADIOLYSIS OF ALKYL KETONES. Bakh, N. A.; Borisenko, G. L.; Kostin, A. K.; Revina, A. A. (Inst. of Electrochemistry, Moscow). Int. J. Radiat. Phys. Chem.; 4: No. 2, 121-34(May 1972). (In Russian).

The transient radiolysis products of alkyl ketones were studied by pulse radiolysis spectral methods in the liquid state as well as by ESR, spectrophotometry and radiothermoluminescence in frozen samples. Electron irradiation with 2.2 μs pulses, 4-MeV mean energy, 1 to 5×10^{17} eV g^{-1} doses in pulse and 5 μs to 5 ms time scale was used in the liquid, and γ irradiation at 77 K with 1.4 to 1.8×10^{16} eV g^{-1} s^{-1} dose rate in the solid state. Methylalkylketones CH_3CO R with R = C_2H_5, n-C_3H_7, n-C_4H_9, n-C_5H_{11}, n-C_6H_{13}, dialkylketones RCOR, R being C_2H_5, n-C_3H_7, n-C_4H_9, and methylcyclohexylketone $CH_3COC_6H_{11}$ were examined. In the liquid phase a transient optical absorption in the 300 to 400 nm range with a sharp maximum at 330 to 340 nm was observed in all the ketones investigated, its intensity being higher in dialkyl- than in methyl alkyl ketones, increasing with the alkyl-chain length and decaying by a first order process, with $k \approx 10^3 – 10^4$ s^{-1}. In γ-irradiated glassy methyl cyclohexyl ketone (MCHK) the optical absorption spectrum comprises a band with a sharp maximum at 325 nm and a second band with $\lambda_{max} \approx 560$ nm. (auth) (In Russian)

38280 CHARGE TRANSFER AT OXIDE SURFACES: ADSORPTION OF CHLORINE AND OXYGEN ON MgO. Tench, A. J.; Kibblewhite, J. F. J. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Phys. Lett.; 14: No. 2, 220-2(15 May 1972).

The adsorption of chlorine on MgO in-vacuo leads to an ESR signal with g-factors of 2.008 and 2.002, and to the appearance of a peak in the reflectance spectrum at 440 nm. This reflectance peak is attributed to donor sites, which are probably pairs of O^- ions, close to the surface of the MgO. It is shown that γ-irradiation of the O_2/MgO system leads to the formation of similar signals. (auth)

38281 OPTICAL ABSORPTION SPECTRUM OF TRAPPED ELECTRON IN CRYSTALLINE ICE AT -150°C. PULSE-RADI-

OLYSIS STUDY. Kawabata, K.; Horii, H.; Okabe, S. (Radiation Center, Osaka). Chem. Phys. Lett.; 14: No. 2, 223-5(15 May 1972).

A pulse radiolysis study of single crystals of D_2O ice at −150°C was made. In addition to the visible absorption with peak at 6300 Å due to trapped electrons, a broad ir absorption with a peak-like structure at 10000 Å was found at the end of the electron beam pulse of 5-μsec duration. The absorption of the ir region decays faster than that of the visible region. The ir absorption seems to be due to electrons trapped in shallow traps. The striking transformation from ir to the visible region, such as in ethanol, cannot be observed. In a sample of D_2O crystals doped with 10^{-2} M NH_4F, about 10% of the absorption in the visible region shows delayed building up with a half-life of about 0.1 msec. (auth)

38282 IONIZATION PROCESSES IN POLAR SOLUTION OF TRYPTOPHAN AT 77°K. Moan, J. (Norsk Hydro's Inst. for Cancer Research, Oslo). Israel J. Chem.; 9: No. 6, 637-43(1971).

The triplet absorption spectrum of tryptophan in ethylene glycol–water glass at 77°K was registered. It is demonstrated that light of wavelength 250 nm produces trapped electrons by a two-photon process in this system. In both uv- and x-induced ionization the probability that an ejected electron will recombine with its mother ion is around 0.5. Bleaching with visible light causes the trapped electrons to react with the solvent and there is also a considerable degree of retrapping. The retrapping becomes more probable when the temperature increases. (auth)

38283 PHOTOPHYSICAL SEPARATION AND IDENTIFICATION OF REACTIVE FREE RADICALS. Behrendt, S. (Carleton Univ., Ottawa). Separ. Sci.; 7: No. 3, 199-216(1972).

An analytical method is proposed for volatilizable free radicals. In a film of liquid helium II, they are floated by heat-flush, heated selectively by nondestructive radiation, and separated by heat-exchange force, with which their spectra are then scanned. Alternative photophysical processes are briefly described. An adaptation of the heat-exchange method is suggested as an aid in the analysis of free radicals formed in irradiated solids. The heat-exchange method is shown to be important in the ultrapurification of materials. (auth)

38284 RADIOLYSIS OF SYNTHETIC PETROL IN THE PRESENCE OF NITRIC ACID. Solyanina, I. P.; Barelko, E. V. At. Energ. (USSR); 32: No. 5, 395-400(May 1972). (In Russian).

Since previous studies have shown that radiation effects on the diluent are important in the solvent extraction of zirconium using TBP–hydrocarbon systems, the radiolysis of synthol (a motor fuel) in the presence of 3M HNO_3 under the action of γ radiation from ^{60}Co at a dose rate of 2.3×10^{16} eV/ml · sec in a broad range of doses up to 6.7×10^{20} eV/ml was investigated. Radiation-induced decomposition of the synthol was studied as functions of the oxygen, HNO_3, olefin, and alcohol concentrations, and of the method of preliminary pretreatment of the synthol. The removal of certain alcohol impurities from the synthol resulted in lowering the G-value, and lowering the distribution coefficient of zirconium. Alkaline treatment of the organic phase yielded more emulsion with the irradiated synthol than was the case after removal of impurities by sulfonation or hydrogenation. Kinetic equations describing the radiolysis rates of HNO_3 and nitration of the diluent are presented. The results of the calculations are in close agreement with the experimental data. (K.S.W.)

38285 GAMMA RADIOLYSIS OF ACETALDEHYDE VAPOR. Dohmaru, Takaaki; Taniguchi, Setsuo. Annu. Rep. Radiat. Center Osaka Prefect.; 12: 86-90(1971).

The effects of pressure, dose, dose rate, scavengers, and temperature on the radiolysis of acetaldehyde vapor were investigated. The results are consistent with the occurrence of the following reactions at room temperature: $CH_3CHO \rightsquigarrow H + CH_3 + CO$; $CH_3CHO \rightsquigarrow H + CH_3CO$; $H + CH_3CHO \rightarrow H_2 + CH_3CO$; $CH_3 + CH_3CHO \rightarrow CH_4 + CH_3CO$; $CH_3CO \rightarrow CH_3 + CO$; and $2CH_3CO \rightarrow (CH_3CO)_2$. The activation energy for the formation of methane, carbon monoxide, and hydrogen was 12.4, 12.4, and ~0 kcal/mole, respectively (0° to 80°C). On the basis of the results obtained from acetaldehyde–acetaldehyde-d_4 mixtures, contributions of hydrogen production processes were estimated. Ionic processes were taken into consideration to elucidate the high yield of the initial chemical conversion. (auth)

38286 RADIOLYSIS OF LITHIUM OXALATE INDUCED BY THE REACTION $^6Li(n,\alpha)^3H$. II. STUDY BY NONDESTRUCTIVE METHODS. Gal, O.; Baugh, P. J.; Phillips, G. O. (Univ. of Salford, Eng.). Int. J. Radiat. Phys. Chem.; 4: No. 2, 159-69 (May 1972).

The radiolysis of lithium oxalate induced by alpha and ^3H particles was studied by ir spectroscopy and thermal analysis. The presence of lithium carbonate in irradiated samples was directly proved by x-ray and ir spectral analysis. The material balance in the overall radiolytic process $Li_2(COO)_2 \rightsquigarrow Li_2CO_3 + CO$ was attained within 100 ± 7% using for lithium oxalate and lithium carbonate determinations ir spectral measurements, and for the CO release the weight loss by thermogravimetric analysis. Some preliminary esr and diffuse reflectance spectroscopic studies were performed. (auth)

38287 GRAFT COPOLYMERIZATION OF ACROLEIN TO POLYSTYRENE BY GAMMA IRRADIATION. Miyauchi, Shinnosuke; Ohnishi, Shunji (Research Inst. for Polymers and Textiles, Yokohama, Japan). Kobunshi Kagaku; 29: No. 323, 207-12 (May 1972). (In Japanese).

Acrolein was graft-copolymerized onto polystyrene film with γ rays in ethanol, carbon tetrachloride, and a carbon tetrachloride–ethanol mixture. The amount of grafting in the mixture is smaller than that in ethanol. The grafting yield decreases with an increase in carbon tetrachloride. The copolymer obtained in the mixture is soluble in cold benzene whereas that prepared in ethanol is insoluble. Infrared spectra and aldehyde analysis revealed that the copolymer chain grows by the polymerization of vinyl groups of acrolein monomer in both solvents, but in the mixture the aldehyde groups are acetalized. (Japan)

38288 INFLUENCE OF VERY LOW TEMPERATURE ON THE RADIATION DAMAGE OF ORGANIC CRYSTALS IRRADIATED BY 100-keV ELECTRONS. Siegel, G. (Technische Univ., Berlin). Z. Naturforsch.; 27a: No. 2, 325-32(Feb 1972). (In German).

The radiation damage of electron–irradiated organic compounds (paraffin, tetracene) was investigated in the temperature range 300 to 4°K. The radiation damage was measured by the decrease of diffraction intensities or the contrast of extinction contours. The damage of the crystals at 4°K required considerably higher electron doses than at 300°K. This result is explained as follows. The total radiation damage proceeds by two steps: (1) by primary radiation damage, excitation of energy levels with subsequent dissociation, which is almost temperature-independent and (2) by secondary radiation damage, diffusion of molecular fragments, which decreases strongly with decreasing temperature. (auth)

38289 MEDIUM REARRANGEMENT ENERGY IN THE THEORY OF THE SOLVATED ELECTRON. Jortner, Joshua (Tel Aviv Univ., Israel). J. Chem. Phys.; 57: No. 1, 587-8 (1 Jul 1972).

The medium rearrangement energy is defined and it is shown that the medium orientational polarization energy just provides one component to this energy. The molecular model aids in understanding the solvated electron. (M.C.G.)

38290 COMMENT ON RADICALS FORMED IN X- OR γ-IRRADIATED CRYSTALS OF COMPOUNDS CONTAINING AMIDE AND/OR NITRILE GROUP. Lin, W. C.; Cyr, N.; Toriyama, K. (Univ. of British Columbia, Vancouver). J. Chem. Phys.; 56: No. 12, 6272(15 Jun 1972).

The ESR spectra of irradiated single crystals of cyanoacetamide and cyanoacetic acid were investigated. In cyanoacetamide it was established that the radical formed was $\cdot N = CHCH_2CONH_2$; in cyanoacetic acid the radical species is attributed to $\cdot N = CHCH_2COOH$. This supplies evidences for the reassignment of radicals formed in X- or γ-irradiated malonamide and cyanoacetylurea to $\cdot N = CHCH_2CONH_2$ and $\cdot N = CHCH_2CONHCONH_2$, respectively. (M.C.G.)

38291 POLARIZATION ENERGY IN THE THEORY OF THE SOLVATED ELECTRON. Tachiya, Masanori (Tokyo Univ.). J. Chem. Phys.; 56: No. 12, 6269-70(15 Jun 1972).

Two equations for the polarization energy of solvated electrons are developed. One is by a factor of 3 or 4 smaller than the other. It is shown that previous calculations involve inconsistency or incorrectness. (M.C.G.)

38292 SOLUTION POLYMERIZATION OF ETHYLENE BY IONIZING RADIATION IN THE PRESENCE OF CHLOROFLUORINATED HYDROCARBONS. Kagiya, Tsutomu; Hagiwara, Miyuki; Okamoto, Hidemasa (to Japan Atomic Energy Research Inst.). U. S. Patent 3,663,391. 16 May 1972. Priority date 25 Apr 1968, Japan.

Ethylene is irradiated with ionizing radiation under high pressure and in the presence of a chlorofluorinated hydrocarbon with the general formula $C_nF_mCl_{2n+2-m}$ wherein n is 1 or 2 and m is 1 to 3 when n is 1 and 1 to 5 when n is 2. A high-molecular-weight polyethylene is thus readily obtained and in a good yield. (auth)

38293 HYDROGEN PEROXIDE YIELD IN GAMMA-IRRADIATED AIR-SATURATED ICE AT 77°K. Moorthy, P. N.; Rao, K. N. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 14: No. 1-2, 113-17(May 1972).

The concentration of hydrogen peroxide formed in thawed γ-irradiated air-saturated ice was studied as a function of dose over the range: 3.8×10^{17} eV/ml to 5.6×10^{19} eV/ml. The concentration dose data do not fit a linear plot. Three empirical equations were tried to fit the experimental data. Of these equations, the one of the form $C = [(1 + \sigma D) - 1]/\beta$ is found to fit the data very closely, and also predicts log C to vary linearly with log D at high doses as found experimentally. By extrapolation of this equation to zero dose GH_2O_2 is evaluated to be 0.32. (auth)

38294 ABSORPTION OF γ RADIATION IN RADIATION-CHEMICAL REACTORS IN PROCESSES CARRIED OUT IN HETEROGENEOUS AGITATED SYSTEMS. Popova, L. V.; Terent'ev, B. M.; Kulikova, N. V.; Dubnova, S. K.; Breger, A. Kh. This paper was summarized in At. Energ. (USSR); 30: No. 5, 447(May 1971) as paper No. 488/5806. (In Russian).

Full copy of this paper is held by TIC.

The Monte Carlo method was applied to calculations of the γ-emission energy distribution of ^{60}Co in a radiation-chemical reactor with a heterogeneous medium under irradiation. A test-stand facility used in the synthesis of dibutyltin dibromide was employed to determine the energy of γ-radiation absorbed in the source, in the structural members, and in the reaction volume of the chemical reactor. The reaction mixture constitutes a heterogeneous system consisting of metallic tin powder and liquid butyl bromide. (auth)

Radiochemistry and Nuclear Chemistry

Refer also to abstract 39859.

Hot-Atom Chemistry

38295 (COO-2170-1) HOT ATOM CHEMISTRY GROUP. Progress Report for the Year Ending December 31, 1971. Dubrin, James (Massachusetts Inst. of Tech., Cambridge). 7p. Dep. NTIS.

Research progress is reported on atomic hydrogen reactions at high kinetic energies and various inelastic ion–molecule processes at elevated translational energies. (M.C.G.)

38296 (RISO-255) MOESSBAUER-BEAM EXPERIMENT AND ITS POSSIBLE APPLICATIONS IN THE STUDY OF CHEMICAL EFFECTS OF THE ^{56}Fe(n,γ)^{57}Fe REACTION. Fenger, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec 1971. 18p. Dep. NTIS (U.S. Sales Only).

The ^{56}Fe(n,γ)^{57}Fe reaction can be used to populate the 14-keV Moessbauer level in ^{57}Fe. This offers in principle a possibility of nondestructive investigation of the chemical effects of neutron capture-γ recoil in iron compounds. Targets of $K_4Fe(CN)_6 \cdot 3H_2O$ and $Fe(COO)_2 \cdot 2H_2O$ were irradiated in a neutron beam and simultaneously used as sources in a Moessbauer experiment. No resonances were detected with $K_4Fe(CN)_6 \cdot 3H_2O$, but weak resonances from $Fe(COO)_2 \cdot 2H_2O$ suggest that in this compound some recoil ^{57}Fe is stabilized as divalent iron. Various improvements of the experimental setup are considered; however, it appears that such experiments are not very promising from a "hot-atom chemistry" point of view. (auth)

38297 TIME DEPENDENT THEORY OF HOT-ATOM REACTIONS. Keizer, Joel (Univ. of California, Davis). J. Chem. Phys.; 56: No. 12, 5958-62(15 Jun 1972).

A simple time-dependent theory of hot-atom reactions in a dilute host gas was developed based on Porter's stochastic theory of hot-atom reactions. Kinetic equations governing the time behavior of the hot-atom probability distribution as well as the concentration of hot atoms were derived. If the frequency of collisions is significantly larger than the reaction rate, it is shown that the probability distribution will relax to a steady state form. The steady state distribution can be used to define hot-atom reaction rate constants and these constants are directly related to product yields. By comparing the time dependent theory to usual kinetic type theories, it is shown that whenever the steady state theory is valid, it gives results identical to those based on the Miller–Dodson formula. (auth)

38298 RRKM THEORY, THE CH_3NC PARADOX, AND THE DECOMPOSITION OF HOT-ATOM SUBSTITUTION PRODUCTS. Bunker, Don L. (Univ. of California, Irvine). J. Chem. Phys.; 57: No. 1, 332-5(1 Jul 1972).

"Paradox" and "contrary to RRKM predictions" are descriptions that have been applied to secondary unimolecular reactions following hot-atom substitution. These processes are strongly influenced by rotational effects that have until now been ignored. The crudest theoretical construction suffices to account for the curious behavior of CH_2TNC in terms of a reasonable (sharply peaked, high energy) excitation function for T-for-H substitution. The reactions of vibrationally energized $CH_3CF_2^{18}F$, $CH_2^{18}FCF_3$, and CH_3T can also be interpreted, with plausible critical configurations and excitation functions. (auth)

Properties of Radioactive Materials

38299 (AAEC/TM-611) LIGHT SCATTERING METHODS AND THEIR APPLICATION TO THE STUDY OF THE PRECIPITATION OF AMMONIUM DIURANATE USING A SIMPLE AND NOVEL APPARATUS. Szego, L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1972. 44p. Dep. NTIS (U. S. Sales Only).

Light scattering theory and practice, especially as it applies to the precipitation of alkaline U(VI) products, is critically reviewed. A simple and novel apparatus is described and some possibilities for further applications and some improvements are discussed. (auth)

38300 (LA-4902) APPARATUS FOR THE MASS PRODUCTION OF CHLORELLA PYRENOIDOSA WITH 94 PERCENT $^{13}CO_2$ AND 6 PERCENT $^{12}CO_2$ AS A CARBON SOURCE. Buchholz, J. R.; Adams, W. H.; Christenson, C. W.; Johnson, G. L.; Kollman, V. H.; Fowler, Eric B. (Los Alamos Scientific Lab., N. Mex.). Apr 1972. Contract W-7405-eng-36. 5p. Dep. NTIS.

The design and construction of fully automated equipment for mass culturing of chlorella pyrenoidosa in an atmosphere of 94% $^{13}CO_2$ and 6% $^{12}CO_2$ is described. A 5-liter prototype box produced about 5 g/liter dry weight of algae in five days. Seventy-two percent of the available carbon was converted to cell mass and 16% was returned to the medium as soluble organic compounds. (auth)

38301 (MLM-1871) AQUEOUS PLUTONIUM CHEMISTRY: SOME MINOR PROBLEMS. Silver, G. L. (Mound Lab., Miamisburg, Ohio). 26 May 1972. Contract AT-33-1-GEN-53. 68p. Dep. NTIS.

A method is presented for estimating the distribution of plutonium valence states in dilute aqueous acids that do not contain sequestering agents. The effects of plutonium disproportionation reactions on the acidity of plutonium solutions are discussed and a method for estimating such effects is illustrated with a computer program. Effects of uncertainties in the solubility product of tetravalent plutonium hydroxide on the pH region calculated to yield a maximum equilibrium concentration of pentapositive plutonium are described, and an analogy between aqueous tetravalent plutonium and a weak acid is suggested. The free energy of formation of tetravalent plutonium polymer is estimated as about −340 kcal/mole Pu, and this estimate is used to define the region of acidity and plutonium concentration that is conducive to the formation of plutonium polymer. Also mentioned is the reaction of plutonium with hydrogen peroxide, the temperature stability of pentapositive plutonium, and the study of plutonium in natural waters. (auth)

38302 CHEMICAL TRANSPORT OF URANIUM SULFIDES AND SELENIDES. Sevast'yanov, V. G.; Ellert, G. V.; Slovyanskikh, V. K. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 1, 16-19(Jan 1972). (In Russian).

Monocrystals of some sulfides and selenides of uranium were grown by the method of chemical transport. Compositions having the following formulas are discussed: $US_{1.5}$, U_3S_5, $US_{1.8}$, β-US_2, U_3Se_5, $USe_{1.87}$, USe_3, and β-USe_2. The effect of various conditions on transport of these compounds was studied, and transport mechanisms are proposed. (K.S.W)

38303 VIBRATIONS OF BRIDGE CARBOXYL GROUPS IN LUMINESCENCE SPECTRA OF SOME URANYL ACETATES. Alikhanova, Z. M.; Zolin, V. F.; Fisher, P. S.; Ellert, G. V. Zh. Neorg. Khim.; 17: No. 3, 762-4(Mar 1972). (In Russian).

The luminescence spectra of a series of uranyl acetates were investigated. Among these were complex acetates with triphenylphosphine oxide, and acetate/propionate complexes with lanthanum, having the formulas $LaUO_2(CH_3COO)_5 \cdot n\ H_2O$ and $LaUO_2(C_2H_5COO)_5 \cdot 3\ H_2O$. Vibrational frequencies in the region 620 to 640 cm^{-1} attested to the presence of complex uranyl carboxylates with a bridge structure. (K.S.W.)

38304 POTENTIOMETRIC DETERMINATION OF STEPWISE STABILITY CONSTANTS OF ZIRCONIUM AND THORIUM CHELATES FORMED WITH ASPARTIC AND GLUTAMIC ACIDS.

Singh, M. K.; Srivastava, M. N. (Univ. of Allahabad, India). Talanta; 19: No. 5, 699-700(May 1972).

The metal chelates of Zr(IV) and Th(IV) with aspartic and glutamic acids were studied potentiometrically. Stepwise stability constants in 0.1M sodium perchlorate at 25°C are reported as: asparate chelates—log K_1 9.70, log K_2 6.85, and log K_3 3.50 for Zr, and log K_1 9.23, log K_2 8.57, log K_3 4.55, and log K_4 3.87 for Th; glutamate chelates—log K_1 9.60, log K_2 6.40, and log K_3 3.32 for Zr, and log K_1 9.11, log K_2 8.52, log K_3 4.18, and log K_4 3.62 for Th. (auth)

38305 DIPHENYL SULPHOXIDE COMPLEXES OF OXOVANADIUM(IV) AND DIOXOURANIUM(VI). Savant, V. V.; Patel, C. C. (Indian Inst. of Science, Bangalor). J. Inorg. Nucl. Chem.; 34: No. 4, 1462-5(Apr 1972).

The preparation and properties of the following complexes of oxovanadium (IV) and dioxouranium (VI) are discussed: $VOBr_2(DPSO)_3$, $VOC_2O_4(DPSO)_2$, $UO_2Br_2(DPSO)_2$, $[UO_2(DPSO)_4]I_2$, and $[UO_2(NCS)(DPSO)_2](NCS)_2$. (D.H.M.)

38306 RADIOLYTICALLY GENERATED GASES IN PLUTONIUM–NITRIC ACID SOLUTIONS. Kazanjian, A. R.; Horrell, D. R. (Dow Chemical Co., Golden, Colo.). Radiat. Eff.; 13: No. 3-4, 277-80(Apr 1972).

Nitric acid solutions containing plutonium were prepared and stored for various periods. The amount and composition of the gases generated by the α radiation were then determined. The G (total gas) decreased from 0.20 to 0.02 as the HNO_3 concentration was increased from 1 to 10M. The main products were H_2 and O_2. Hydrogen was formed by the radiolysis of H_2O; its yield decreased with increasing HNO_3 concentration because the H atoms were more effectively scavenged by nitrate ions. Oxygen was formed by the catalytic decomposition of H_2O_2. The reaction of H_2O_2 with HNO_2, the main radiolysis product in HNO_3 solution, takes precedence over the decomposition as the HNO_3 concentration increases, thereby decreasing the O_2 yield. (auth)

38307 BEHAVIOUR OF THE THIODIPROPIONIC COMPLEX OF In(III) AND U(VI) AT THE DME IN AQUEOUS AND AQUEOUS METHANOLIC SOLUTIONS. Rawat, P. C.; Gupta, C. M. (M.R.E. Coll., Jaipur, India). Talanta; 19: No. 5, 706-7(May 1972).

The complexation of In(III) and U(VI) with thiodipropionic acid was investigated polarographically in water and water–methanol solutions at 30 ± 0.1°C. All the chelates belong to polarographically reversible systems. With indium(III), complexes with metal to ligand ratios of 1 : 1, 1 : 2, 1 : 3, and 1 : 4 were found at pH 4.8. Uranium(VI) was found to form three successive complexes with metal to ligand ratios of 1 : 1, 1 : 2, and 1 : 3 in 0.1M HCl, with 0.1M KCl as supporting electrolyte. (auth)

38308 EFFECTS OF CHARGED AND UNCHARGED SURFACTANTS ON POLAROGRAPHIC WAVES OF URANIUM(VI) IN PHOSPHORIC ACID SOLUTIONS. Issa, I. M.; Tharwat, M.; Elewady, Y. A. (Assiut Univ., Egypt). Electrochim. Acta; 17: No. 6, 1075-84(Jun 1972).

The effects of charged (anionic and cationic) and uncharged (non-ionic) surfactants (SAS) on the polarographic waves of uranium(VI) in phosphoric acid solutions of concentrations 0.1, 1, 5, and 10 M were investigated. The non-ionic surfactant (Triton X-100) was found to cause retardation of reactions in all media, whereas the effects of a charged SAS depends upon the acid concentration. Thus, the cationic surfactant, dodecylamine perchlorate, causes enhancement of the reduction process at lower acidities, and its retardation at high acid concentrations. The anionic surfactant, sodium dodecyl sulphate, shows approximately an opposite effect. The results are discussed in terms of complexing action of the supporting electrolyte, the effect of the adsorbed SAS layer on the charge distribution of the double layer and the specific adsorption of phosphate anions. The effects of SAS on the different waves were traced by following the changes that occur in the values of the different kinetic parameters in the presence of increasing amounts of these materials. (auth)

38309 DESIGN, CONSTRUCTION, AND OPERATION OF AN ISOPERIBOL SOLUTION CALORIMETER AND URANYL–URANIUM(IV) SYSTEM. Kothari, Pratap S. Detroit; Wayne State Univ. (1971). 125p. University Microfilms Order No. 72-14,585.

Thesis.

A detailed description is given of design, construction, and operating characteristics of a precision isoperibol solution calorimeter and its operating systems. The calorimeter is of the semiadiabatic type and is provided with an isothermal jacket. It has a usable volume of 450 cc and an energy equivalent of 154.6 ± 1.9 J (36.95 cal). One- and two-body models in theory of operation of isoperibol calorimeters and temperature correction methods were reviewed. The performance of 2-amino-2-(hydroxymethyl)-1,3-propanediol (TRIS) and potassium chloride as solution calorimetry comparison standards was evaluated. It was established that both of these have some drawbacks, but of the two, TRIS is the more preferable calorimeter comparison standard. Some thermodynamic and photovoltaic studies on the uranyl–uranium(IV) system are described. Thermochemical measurements were made in perchloric acid medium, and the following thermodynamic constants were determined for the reaction: $U^{4+}_{aq} + 2H_2O \rightarrow UO^{2+}_{2\,aq} + 4H^+_{aq} + 2e^-$, $\Delta H^0 = 126.25$ kJ, ΔG^0 . 63.18 kJ, and $\Delta S^0 = 211.53$ J. Photovoltaic studies were made in acetic acid medium. The effect of varying uranyl ion concentration, pH, and ethyl alcohol concentration on emf of these cells in the presence and absence of light was studied. The nature of the reactions occurring in the above cells and their reversibility in the presence and absence of light has been established. A mechanism for reduction of uranyl ions in organic media in presence of light was proposed. (Diss. Abstr. Int., B)

38310 SYNTHETIC AND SINGLE CRYSTAL NUCLEAR MAGNETIC RESONANCE STUDIES OF THE METAL CARBONYLS. Slater, James Louis. Tallahassee; Florida State Univ. (1971). 118p. University Microfilms Order No. 72-13,566.

Thesis.

A new manganese carbonyl anion $[H_2Mn_3(CO)_{12}]^{-1}$ was prepared by irradiation of a sample of dimanganesedecacarbonyl in acetone with uv light. A triangular structure with two bridging hydrogens was assigned to the new ion by the ir and raman spectra. The historically important compound, uranium carbonyl, was prepared by the reaction of u atoms with CO in an Ar matrix at 4°K. Several uranium carbonyl species were detected by the strong ir bands in the carbonyl stretching region of the spectrum. Since only U, CO, and Ar were present in the matrix, the new infrared bands must be C–O stretching frequencies of uranium carbonyls. The final product of the "annealing" experiments was assigned to $U(CO)_6$ and frequencies were assigned to all of the intermediate species $U(CO)_{1-6}$. The assignments were made by analogy to the tantalum carbonyl system $Ta(CO)_{1-6}$. All of the previously known metals forming carbonyls were members of the d transition series; this was the first preparation of an actinide carbonyl. The orientation of the electric field gradient tensor was measured in a single crystal of dicobalt octacarbonyl at liquid nitrogen temperature. The z-axis of the field gradient tensor was found to lie in the direction of the missing third bridging carbonyl as predicted by earlier workers. The prediction was based on the structural model of a linear Co–Co bond and a lone pair of electrons in the direction of the missing bridging carbonyl. This work, therefore, lends support to this model of the bonding in dicobalt octacarbonyl as opposed to the "bend" bond model. The quadrupole coupling constants and asymmetry parameters were measured by single crystal nuclear magnetic resonance for four single crystals of the $X_3M{-}Mn(CO)_5$ (M = Si, Ge, Sn, Pb; X = Cl, Br, C_6H_5) series. The coupling constants were 7.3 MHz (X_3M is Cl_3Sn), 12.04 MHz (X_3M is $(C_6H_5)_3Pb$), 18.33 MHz (X_3M is $(C_6H_5)_3Sn$), and 24.636 MHz (X_3M is $(C_6H_5)_3Ge$). The quadrupole coupling constants were related to the Alfred–Rochow electronegatives and were discussed by comparison to empirical predictions derived from NQR data on the similar $X_3M{-}Co(CO)_4$ (M = Si, Ge, Sn, Pb; X = Cl, Br, I, C_6H_5) series. The asymmetry parameters were in the range 0.11 to 0.37. (Diss. Abstr. Int., B)

38311 NUCLEAR MAGNETIC RESONANCE STUDIES OF THE CHELATION OF URANYL IONS BY ADENINE NUCLEOTIDES. Rich, Kenneth Eugene. Rochester, N. Y.; Univ. of Rochester (1971). 210p. University Microfilms Order No. 72-14,706.

Thesis.

The structures of the various complexes present in neutral and alkaline mixtures of uranyl nitrate and the three adenine 5′-nucleotides, adenosine 5′-monophosphate (AMP), adenosine 5′-diphosphate (ADP), and adenosine 5′-triphosphate (ATP) were investigated by NMR studies. Elucidation of these systems is important because of the possible involvement of U–ATP complexes in uranium inhibition of sugar transport into a biological cell, the use of uranyl compounds in tissue staining, and the possibility that this information may be useful in unraveling the mechanism of metal ion catalysis of the hydrolysis of ATP. Nuclear magnetic resonance spectra, both proton (100 MHz) and phosphorous (40.5 MHz), were obtained for U–AMP, U–ADP, and U–ATP mixtures in D_2O having various stoichiometries and basicities over the pD range ~7 to 11. The spectra of U–AMP indicate that in equimolar mixture (0.1M and 0.05M) the strong chelate with 1 : 1 stoichiometry (whose structure was previously given as a 2 : 2 sandwich-type (ST) dimer), which is exclusively present above pD 10.9, disproportionates below this pD to uncomplexed AMP, sandwich-type chelates (two forms) with 2 : 1

(U–AMP) stoichiometry, and non-sandwich-type (non-ST) complex(es). Only the latter type of complex is present at pD 7.5 in 0.05M equimolar mixture. The extent of disproportionation and the ligand exchange rate both increase with decreasing pH, probably due mainly to the competition between uranyl ions and protons for the ribose hydroxyl-oxygen sites. Structures for the 2 : 1 chelates, and also 3 : 1 chelates, compatible with the spectra are suggested. A series of equilibria are suggested to describe the U–AMP system from pH 2. to 11.5. The spectra also show that from pD 7.7 to 11 an equimolar U–ATP mixture consists of 2 : 2 ST dimeric chelates in which the ligands are the β and γ phosphoryl groups and the ribose hydroxyls, but from pD 6.8 to 7.3 non-ST chelates in which the uranium is bound only to the β and γ phosphoryl groups predominate. About 10% of the complex is in the ST form at pD 7.3 in 1 : 1 0.05M U–ATP solution, but none is present in a 1 : 2 solution at the same pD and uranium concentration. Unlike the U–ATP and U–AMP systems, the U–ADP system does not contain 2 : 2 ST complexes at any pD. Rather, at pD 7.7 only non-ST complexes, in which uranium is chelated by the two phosphoryl groups, exist in 1 : 1 and 1 : 2 U–ADP mixtures, but these disproportionate to 4 : 2 ST chelates and free ADP above pD 7.7. Unlike the behavior of non-ST U–AMP complexes, U–ADP non-ST complexes (adenine) ring-stack to a greater extent than do free ADP ions. The U–ATP complex (non-ST form) dephosphorylates completely to the non-ST U–ADP complex in near-neutral solution within two days at 27°C, but at higher pD, 9.7, dephosphorylation of U–ATP (ST form) directly to the U–AMP ST complex seems to occur. The relative stabilities of the 2 : 2 uranyl ion-adenine nucleotide sandwich-type chelates were shown to be U–ATP ≫ U–AMP ≫ U–ADP with respect to dissociation and/or disproportionation. A study of the chelate models constructed from the CPK atomic models suggests that the order of stabilities of the three 2 : 2 ST chelates might be due to ring strain in U–AMP, which is absent in U–ATP, and to the greater flexibility of the 4 : 2 ST U–ADP structure relative to that in the 2 : 2 ST U–ADP structure. The elucidation of the structures of the various complexes present in uranyl ion-adenine nucleotide solution has led to postulation of a mechanism for the non-enzymatic catalysis of ATP hydrolysis by strongly hydrolyzable metal ions and a mechanism for enzymatic metal ion catalysis of ATP hydrolysis. (Diss. Abstr. Int., B)

38312 SOME PHYSICOCHEMICAL PROPERTIES OF THE COMPOUND $XeF_2.UF_6$. Ezhov, V. K. This paper was summarized in At. Energ. (USSR); 30: No. 4, 383(Apr 1971) as paper No. 476/5835. (In Russian).

Full copy of this paper is held by TIC.

The possible existence of the compounds in the vapor phase was investigated by two methods. The first technique relies on a study of the behavior of a vapor-phase equimolar mixture of uranium hexafluoride and xenon difluoride at different temperatures. The second technique involves investigating the possibility of selective isolation of uranium hexafluoride from the compound with xenon difluoride existing in a condensed state. The existence of the compound $XeF_2 \cdot UF_6$ in the vapor phase was not detected successfully by either of these techniques. Processing of experimental data on determinations of the dissociation pressure of the compound $XeF_2 \cdot UF_6$ as a function of the temperature showed that the dependence described by the equation $\lg p_{mm} = 9.30 - 2171/T°K$, holds in the temperature range from 24 to 100°C. The heat of dissociation of the complex $XeF_2 \cdot UF_6$ was calculated over that temperature range. It was found to be a constant, 18.6 ± 0.5 kcal/mole (77.9 ± 2.1 kJ/mole). The heat of fusion of the compound $XeF_2 \cdot UF_6$ was determined thermographically from the area under the peak on the differential curve. The error allowed as a result of the approximations in those calculations was not greater than 0.3%. The average heat of fusion of the compound $XeF_2 \cdot UF_6$ was 3.5 ± 0.3 kcal/mole (14.6 ± 1.3 kJ/mole). (auth)

38313 URANYL HYDROXYACETATE COMPLEXES. Kuzina, M. G.; Lipovskii, A. A. Zh. Neorg. Khim.; 17: No. 4, 1098-1103 (Apr 1972). (In Russian).

The heterogeneous reactions of solid $UO_2Ac \cdot 2H_2O$ and $UO_3 \cdot 2H_2O$ with acetate solutions and tetrakisdecylammonium hydroxide in benzene were investigated. Depending on the ratio of reactants used, various hydroxyacetate compounds were formed, which were characterized by ir absorption spectra. $(R_4N)_2(UO_2)_3Ac_6(OH)_2$, $(R_4N)(UO_2)_2Ac_3(OH)_2$, and $(R_4N)(UO_2)Ac_2OH$ were among the compounds discussed. Additional evidence for the existence of these hydroxyacetate complexes was drawn from phase composition relationships. (K.S.W.)

38314 TEMPERATURE–TIME DEPENDENCE OF LINEAR PROTON RELAXATION IN AQUEOUS SOLUTIONS OF THE UF^{3+} ION. Glebov, V. A. Zh. Neorg. Khim.; 17: No. 4, 1175-6(Apr 1972). (In Russian).

The temperature-time dependence of the longitudinal relaxation of protons was determined in aqueous solutions of the ion UF^{3+} by means of spin echo. The implantation of the fluoride in the coordinate sphere of the U(IV) ion results in strengthening of the U(IV)–H_2O bond. (tr-auth)

38315 MAGNETIC SUSCEPTIBILITY OF COMPLEXES OF URANYL ISOTHIOCYANATE. Belova, V. I.; Shchelokov, R. N.; Orlova, I. M. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 4, 1184-5(Apr 1972). (In Russian).

The magnetic susceptibility of a number of complexes of $UO_2(NCS)_2$ was measured. The adducts studied included such components as H_2O, CH_3CONH_2, $CO(NH_2)_2$, bipyridine, dimethylurea, tetramethylurea, phenanthroline, antipyrine, urotropine, dimethyl sulfoxide, and CH_3COO^-. The uranyl group possessed a weak van Vleck paramagnetism. Possible causes of the high paramagnetism values of some compounds in comparison to others are discussed. (K.S.W.)

38316 STUDY OF THE COCRYSTALLISATION OF Np, Pu, Am, AND Cm WITH SAMARIUM AND EUROPIUM DICHLORIDES, IN AQUEOUS ETHANOLIC SOLUTIONS. Mikheev, N. B.; Kamenskaya, A. N.; Dyachkova, R. A.; (and others) (Inst. of Physical Chemistry, Moscow). Inorg. Nucl. Chem. Lett.; 8: No. 6, 523-8(Jun 1972).

It was found that as a result of the interaction of $SmCl_3$ with Mg metal in acid ethanol solution reduction to Sm^{2+} occurs and $SmCl_2$ is precipitated, and if microquantities of actinides that can be reduced in this system to the divalent state are present in the solution, they undergo true isomorphous cocrystallization with the $SmCl_2$. The crystallization takes place at the surface of the Mg. A similar state of affairs applies in the $EuCl_3$–$EuCl_2$ system. It was considered of interest to study the cocrystallization of microquantities of Np, Pu, Am, and Cm in these systems, and details of the experimental work are described. All the investigated actinides cocrystallized with the $EuCl_2$ and $SmCl_2$. The cocrystallization of microquantities of Yb and Ce with $EuCl_2$ and $SmCl_2$ was also investigated. The cocrystallization coefficients of the investigated actinides and Ce sharply decreased in the presence of macroquantities of $LaCl_3$, and it is considered that the cocrystallization is due to the formation of anomalous mixed crystals. The shorter the Me^{3+} ionic radius (Np → Cm) the lower the value of the cocrystallization coefficient. (UK)

38317 STUDY OF HYDROLYSIS AND COMPLEXING OF URANYL IONS IN SULFATE SOLUTIONS AT ELEVATED TEMPERATURES. Nikolaeva, N. M. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk; No. 3, 61-7(May 1971). (In Russian).

Hydrolysis of uranyl ions at elevated temperatures first was studied in the absence of complexing in dilute nitrate solutions by means of the pH-metric method. It was found that the hydrolysis at 50 to 150°C occurs mainly in the following three reactions: $2UO_2^{2+} + 2H_2O \rightleftharpoons (UO_2)_2(OH)_2^{2+} + 2H^+$, $UO_2^{2+} + H_2O \rightleftharpoons UO_2(OH)^+ + H^+$, and $UO_2(OH)^+ + H_2O \rightleftharpoons UO_2(OH)_2 + H^+$. Equilibrium constants of these reactions were estimated over this temperature range and an equation for temperature dependence of the constants was evaluated: $\lg K_1 = 2{,}066 - 2355/T$, $\lg K_2 = 3{,}668 - 2633/T$, and $\lg K_3 = 4{,}148 - 3268/T$. Equilibrium constants of a dissociation reaction were estimated and the temperature dependence of the constants was found: $\lg K_\pi = -26{,}734 + 13302{,}84/T - 1850422/T^2$ for $UO_2SO_4 \rightleftharpoons UO_2^{2+} + SO_4^{2-}$. (auth)

38318 CHEMISTRY OF THE URANYL GROUP. PREPARATION AND CRYSTAL STRUCTURE OF BIS (NN-DIETHYL DITHIOCARBAMATE) DIOXOTRIMETHYLAMINE OXIDEURANIUM(VI), $UO_2(Et_2NCS_2)Me_3NO$. Forsellini, E. (CNR, Padua); Bombieri, G.; Graziani, R.; Zarli, B. Inorg. Nucl. Chem. Lett.; 8: No. 5, 461-3(May 1972).

This complex was obtained by reacting $UO_2(NO_3)_2 \cdot 6H_2O$ in methanol with the stoichiometric amount of potassium diethyldithiocarbamate and adding a slight excess of Me_3NO in methanol. Yellow-orange orthorhombic crystals suitable for x-ray work were grown from acetone solution. Crystal parameters were a = 13.82, b = 11.36, c = 14.40 Å, space group $P2_12_12_1$. Bond distances and bond angles are shown diagrammatically. The U-atom is in a 7-coordinate pentagonal-bipyramidal environment. A large donor ability of the ligand Me_3NO is indicated. Comparisons are made with the corresponding arsine and phosphine oxide derivatives $UO_2(DTC)_2Ph_3AsO$ and $UO_2(DTC)_2Ph_3PO$. (UK)

38319 AMERICIUM(VI) IN BASIC SOLUTION. Cohen, D. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett.; 8: No. 6, 533-5(Jun 1972).

Two methods for preparing Am(VI) species in alkali hydroxide solution are described, and the absorption spectrum for the species in CsOH is shown. ^{243}Am was employed for the experimental work. The first method involved ozone oxidation of a slurry of Am(III) hydroxide in the base, the latter comprising all alkali hydroxides from LiOH to CsOH. The second method involved ozone oxidation of Am(III) in dilute $NaHCO_3$, acidifying with dilute HNO_3, and finally using strong base to quickly convert to basic solution. The absorption spectrum in CsOH was distinctive and unlike either the spectrum in acid or dilute carbonate. The alkali hydroxide solutions were unstable, and a light tan precipitate was formed in a few hours. This solid was soluble in dilute mineral acids and the absorption spectrum corresponded to Am(V). (UK)

38320 MAGNESIUM AND URANIUM COMPLEX FLUORIDES. Maraval, Simone; Salle, Paul; Dixmier, Jacques; Plurien, Pierre (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C; 274: No. 10, 955-8(6 Mar 1972). (In French).

The existence of unknown defined compounds is suggested by corrosion studies of metals in UF_6, which have, under various conditions, repeatedly revealed anomalies. Direct, total reaction of UF_6 with divalent metals enabled the formation (under similar conditions) of fluoride complexes of the $M(II)U_2F_{12}$ type (M = Cu, Zn, Ni, Mg) to be established. MgU_2F_{12}, however, reacts with UF_6 at a higher temperature to produce a second fluoride complex $MgUF_7$. Quantitative chemical analysis and x-ray crystallography (Debye–Scherrer method) were used. (France)

38321 ELECTRODIALYSIS OF ^{60}Co, ^{106}Ru, AND ^{144}Ce IN SEAWATER THROUGH ION-EXCHANGE MEMBRANES. ON THE EFFECTS OF AGING OF ^{60}Co, ^{106}Ru, AND ^{144}Ce IN SEAWATER. Honda, Yoshihide; Kimura, Yuichiro; Tsurii, Nobuaki (Kinki Univ., Osaka). Radioisotopes (Tokyo); 21: No. 5, 269-75(May 1972).

In order to elucidate the physicochemical behavior of the radionuclides such as ^{60}Co, ^{106}Ru, and ^{144}Ce in seawater, electrodialytic studies on the effects of aging of the radionuclides in seawater were carried out. ^{60}Co in seawater showed not only cationic species, but also electroneutral species with aging. ^{106}Ru in the original form of chloro complexes in seawater showed a relatively large number of well-defined species that can be readily classified into anionic, cationic, electroneutral, colloidal, or particulate, nondialytic, and more or less adsorbable species. With aging, the negatively charged forms slowly decreased changing to positively charged and electroneutral forms. ^{144}Ce in seawater showed initially cationic species. However, electroneutral and negatively charged species were formed with aging. Colloidal or particulate, nondialytic, and more or less adsorbable species of ^{144}Ce were also found. (auth)

38322 ISOSTERIC HEAT OF ADSORPTION FOR WATER ADSORBED ON ThO_2. Ron, Tsvia; Schindler, P. (Univ., Bern). Chimia (Aarau); 26: No. 5, 247-8(15 May 1972).

The isosteric heat of adsorption for water on ThO_2 was measured as a function of the surface coverage. The ΔH_{st} values referring to the formation of the second and third monolayer are smaller than the heat of liquefaction of pure water. (auth)

Radioactive Waste Treatment

Refer also to abstract 40212.

38323 EXTRACTION OF ^{91}Y AND ^{144}Ce FROM AQUEOUS SOLUTIONS BY FOAM FLOTATION. Pustovalov, N. N.; Pushkarev, V. V. At. Energ. (USSR); 32: No. 5, 435-7(May 1972). (In Russian).

Surface-active agents consisting of sodium alkyl sulfates with 10- to 16-carbon-length chains were used to investigate the extraction of ^{91}Y and ^{144}Ce from aqueous solutions at a level of $\sim 5 \times 10^{-6}$ Ci/l. The extraction efficiency of the froth flotation method was evaluated as functions of concentration of the Na alkyl sulfates and of pH of the aqueous solutions. The optimum pH range was 2 to 4 for both isotopes. (K.S.W.)

Radioisotope Production

38324 (AAEC/TM–605) IMPURE: A FORTRAN PROGRAM FOR THE ANALYSIS OF THE GAMMA SPECTRUM OF ^{99m}Tc ELUTED FROM FISSION PRODUCED ^{99}Mo. Hetherington, E. L. R.; Wood, N. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1972. 16p. Dep. NTIS (U. S. Sales Only).

The FORTRAN program IMPURE is used to process the gamma spectrum of ^{99m}Tc eluted from fission-produced ^{99}Mo to determine the levels of ^{99}Mo, ^{131}I, ^{132}I, ^{103}Ru, and ^{140}La impurities. During counting with a Ge(Li) detector and 512-channel analyser, the sample is screened in a 4.0-mm lead pot to reduce the ^{99m}Tc contributions in comparison with the impurities. The program sums the counts accumulated in appropriate spectrum peaks, and calculates the standard deviation. After correction for decay, lead attenuation, detector efficiency, and the interference by overlapping peaks, the activity of each nuclide and its percentage contribution are calculated. The results are displayed in an easily read format. (auth)

38325 (AREAEE–127) ANION EXCHANGE SEPARATIONS OF ANTIMONY AND TIN ISOTOPES ISOLATED FROM FISSION PRODUCTS. Allam, S.; Zakaria, N.; Abdel-Rassoul, A. A. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Chemistry Dept.). 1971. 28p. Dep. NTIS (U. S. Sales Only).

Anion exchange studies were conducted to establish a highly efficient procedure for the separation of antimony and tin isotopes after their isolation from the uranium fission products. Experimental results are provided for the determination of the distribution of Sb^{5+} and Sn^{4+} in malonic and tartaric acid solutions, using Amberlite IRA-400 exchanger. Malonic acid was selected for carrying the column separation at a pH range of 4.5 to 4.8. Complete recovery of the ^{124}Sb activity was achieved by eluting the antimony with 3% malonic acid solution, adjusted to the proper pH with 9M NH_4OH. The ^{113}Sn activity was stripped, by using 9M H_2SO_4 solution as an eluant. (auth)

38326 (ORNL-tr–2612) STUDY OF THE EXTRACTION KINETICS OF URANIUM, PLUTONIUM, RUTHENIUM, AND ZIRCONIUM WITH TRIBUTYLPHOSPHATE WITH LIQUID MIXING IN A CENTRIFUGAL FIELD. Pushlenkov, M. F.; Yakovlev, G. N.; Kuznetsov, G. I.; Tshepetilnikov, N. N.; Kasimov, F. D. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated for Oak Ridge National Lab., Tenn., from report SRARI-P–116. 11p. Dep. NTIS.

Extraction process kinetics were studied. It was established that uranium and plutonium extraction occurs faster than zirconium and ruthenium extraction, the mass transfer of which is defined by slow chemical transformations. It is shown that in some cases the separation factor of the elements may be increased by using the differences in extraction rates. (auth)

38327 RADIOACTIVE AEROSOLS IN THE PRODUCTION OF TRANSPLUTONIUM ELEMENTS UNDER CONDITIONS OF A HOT LABORATORY. Egorova, M. S.; Kopaev, V. V.; Parkhomenko, G. M. Gig. Sanit.; No. 2, 56-60(Feb 1972). (In Russian).

Quantitative assessment was made of the aerosols of transplutonium elements that may be the cause of potential radioactive hazards. (auth)

38328 ELUENT FOR RADIOISOTOPES. Haney, Thomas A.; Bruno, Gerald A. (to E. R. Squibb and Sons, Inc.). U. S. Patent 3,664,964. 23 May 1972. Filed 3 Jul 1968.

An eluent that improves the yield of nuclear radioisotopes from ion exchange resins is described that consists essentially of an isotonic saline solution and an oxidizing agent in a concentration of from 0.001% to about 1.0% on a volume/volume ratio. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 38195, 38200, 38210, 38284, 38406, 38408, and 40226.

38329 (ANL–7850) CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS, JANUARY–DECEMBER 1971. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 189p. Dep. NTIS.

During 1971, investigations were continued in fuel-cycle technology, sodium technology, fast-reactor materials properties, liquid-metal and molten-salt chemistry, reactor safety, thermochemistry, electrochemical energy conversion, fluidized-bed combustion of fossil fuels, and nuclear safeguards. Fuel-cycle studies were directed toward the development of a pyrochemical process for decladding LMFBR fuel, a centrifugal contactor for the plutonium isolation steps in aqueous fuel reprocessing, a process for converting U/Pu nitrates to oxide powders suitable for fuel fabrication, analytical procedures adaptable to in-line use in the fabrication of LMFBR fuel, and a method for the electrolytic reduction of plutonium in Purex processes. In the sodium technology program, research was directed toward the development of on-line monitoring devices for impurities in sodium, the detection and characterization of fuel-element failures, and sodium chemistry relevant to LMFBRs. Administrative and laboratory work was carried out on the national analytical standards program for coolant sodium. Materials studies included the determination of the effect of fuel burnup on oxygen potentials, the phase, reaction, and thermodynamic studies of the U–O–Na and U–Pu–O–

Na systems, and mass-spectrometric studies of the U–Mo–O and U–Cs–O systems. Electron microprobe analysis was used to estimate oxygen-potential gradients in irradiated mixed-oxide fuels using the Mo–MoO_2 system as a redox indicator. High-temperature physical-property data needed for fast-reactor safety analysis were obtained. These included the determination of the enthalpies and heat capacities of Na_3UO_4 and $U_{0.8}Pu_{0.2}O_{1.97}$, the speed of sound in liquid sodium, thermodynamic properties of $UO_{2\pm x}$ by matrix-isolation spectroscopy, and the distribution of fission products between molten iron and molten UO_2. Calorimetric studies included the determination of the enthalpies of formation of Na_3UO_4, Na_2O, $CsHC_2$, ThS, NSF, XeF_2, XeF_4, XeF_6 and BrO_3F. Quantum-chemical investigations were made on the N–F, Si–F, N–S and N–O systems. A dosimetry program was established, and data were obtained on the integral capture-to-fission ratios of the major fissile and fertile isotopes in EBR-II. Fast-neutron fission yields of tritium from ^{235}U and of short-lived, gamma-active nuclides from ^{235}U, ^{238}U, and ^{239}Pu were determined. Phase-equilibrium studies were made on several lithium–chalcogen systems. In work related to fusion reactors, a thermodynamic analysis of existing data on the Li–LiH system was made, and the consequences of tritium permeation in the core of a deuterium–tritium-fueled reactor were estimated. Raman spectroscopic studies of divalent metal halide melts were continued. Infrared spectroscopy was used in the study of reactions of iodine-containing species with molten nitrates. Experimental and theoretical studies of the homogeneous nucleation of vapor bubbles in superheated liquids were initiated. Work was continued on the development of a mathematical model for the solubility of noble gases in liquid metals. The energy conversion program was directed toward improving the performance of lithium/chalcogen cells for use in electric vehicles and as an implantable power source for an artificial heart or as a heart-assist device. Cell studies included research on cathode design, materials, and sealing methods, the effect on cell performance of additives to the cathode reactants, the use of paste and liquid electrolytes, and the scale-up of cells to larger sizes. Work on the fluidized-bed combustion of fossil fuels as a means of controlling the emission of atmospheric pollutants included single-stage and two-stage bench-scale experiments. Also, the mechanism of the lime sulfation reaction and the regeneration of calcium sulfate were explored, and mathematical models were derived for the prediction of SO_2 removal by lime in a fluidized bed. The establishment of safeguards-related criteria for special nuclear material was continued. (auth)

38330 (CONF-720522–1) HYDRODYNAMICS AND MASS TRANSFER IN PACKED COLUMNS. Hannaford, B. A.; Watson, J. S.; Kee, C. W.; Cochran, H. D. Jr. (Oak Ridge National Lab., Tenn.). 1972. 32p. Dep. NTIS.

From seventy-second national meeting of the American Institute of Chemical Engineers; St. Louis, MO. (21 May 1972).

The packed column is suited to processing the small stream of molten fuel salt for isolation of protactinium-233 and removal of rare earths using molten bismuth. Because of the unusually large density difference (6.28 g/cm^3) between bismuth and salt and the large value for the interfacial tension, existing hydrodynamic correlations are not reliable for predicting flooding characteristics and holdup. Experimental work in glass equipment led to a relationship that defines the flooding velocities as a function of packing diameter, void fraction, continuous phase viscosity, and density difference: $V_{slip} = K\, d_p\, \epsilon\, \mu^{-1/4}\, (\Delta\rho)^{1/2}$. Measurements of bismuth-salt flooding rates in a 0.82-in.-diam packed column at 600°C are in satisfactory agreement with the slip velocity predicted by the correlation. Mass transfer experiments in a mild-steel experimental system resulted in the transfer of 63 to 95% of the uranium from salt to the bismuth, at high distribution coefficients where the salt phase resistance was controlling. The data were correlated by the expression $HTU = 18.9/V_B/V_S$ (in.) where the denominator is the volumetric flow ratio of bismuth and salt. Mass transfer experiments utilizing radioactive tracers (^{97}Zr, ^{237}U) at low distribution coefficients indicated that the HTU is about 4.5 ft under these conditions where the bismuth phase resistance was controlling. (auth)

38331 (CONF-720522–2) REMOVAL OF URANIUM FROM MOLTEN FLUORIDE MIXTURES. Hightower, J. R. Jr.; Bell, M. J.; Hannaford, B. A.; McNeese, L. E. (Oak Ridge National Lab., Tenn.). 1972. 25p. Dep. NTIS.

From seventy-second national meeting of the American Institute of Chemical Engineers; St. Louis, MO. (21 May 1972).

The development of a continuous fluorinator for use in the removal of uranium from molten fluoride mixtures by fluorination before extraction of Pa and the rare earth fission products is discussed. From results of small-scale uranium oxide precipitation experiments, it was concluded that oxide precipitation appears to be an attractive alternative to fluorination for removing uranium from fuel salt from which the protactinium has been previously removed. (D.H.M.)

38332 (CONF-720522–3) MOLTEN-SALT BREEDER REACTOR FUEL PROCESSING. McNeese, L. E.; Ferris, L. M.; Nicholson, E. L. (Oak Ridge National Lab., Tenn.). 1972. 37p. Dep. NTIS.

From seventy-second national meeting of the American Institute of Chemical Engineers; St. Louis, MO. (21 May 1972).

The successful operation of a single-fluid molten-salt breeder reactor requires the removal of ^{233}Pa and the fission products in order to hold the absorption of neutrons in these materials to an acceptable level. The reference flowsheet for effecting removal of these materials is based on fluorination for uranium removal, reductive extraction for protactinium removal, and the metal transfer process for rare earth and alkaline earth removal. Progress was made in the development of continuous fluorinators that will be protected from corrosion by a frozen layer of salt. Studies were carried out that allow improved design and evaluation of packed column salt–metal contactors. All steps of the metal transfer process for removing rare earths from MSBR fuel carrier salt were demonstrated and experiments are in progress that use salt and bismuth flow rates that are 1% of the expected flow rates for processing a 1000-MW(e) MSBR. An alternate processing flowsheet is being developed that is based on oxide precipitation for removal of protactinium and uranium and the metal transfer process for removal of rare earths and alkaline earths. The equilibria involved in the oxide precipitation of protactinium are not sufficiently well defined to allow final evaluation of the flowsheet. Processing plants based on either flowsheet will require the use of graphite and molybdenum in portions of the plant that use molten bismuth, and significant progress in the fabrication technology for molybdenum was made. These developments have significantly strengthened the technical basis for processing molten-salt breeder reactors. (auth)

38333 (CONF-720607–16) FUEL REPROCESSING TESTS WITH SHORT-COOLED LMFBR-TYPE FUEL RODS. Goode, J. H.; Vaughen, V. C. A. (Oak Ridge National Lab., Tenn.). 1972. 18p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

Hot cell tests were conducted using short-cooled fuel rods. Each rod contains UO_2 insulator pellets at either end of a stack of 14FTR-type sintered pellets pressed from mechanically blended 25% PuO_2–75% UO_2. No fission gases or tritium were found in the capsule cover gas. Individual rods were punctured to determine the fission gas release. About 60% of the ^{85}Kr and 40% of the ^{133}Xe were released into plenum during irradiation. Release of volatile fission products by high-temperature oxidation voloxidation was tested. It was concluded that head-end shearing of the fuel rods would probably release little or no ^{131}I or tritium along with the xenon and krypton from the plenums. Voloxidation appeared only moderately successful as a method of volatilizing the xenon, krypton, and iodine, but was excellent for removing the tritium from the fuel. (M.C.G.)

38334 (DOCKET-50268–29) MIDWEST FUEL RECOVERY PLANT. Final Safety Analysis Report, Amendment 26. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 9 Jun 1972. 36p. (NEDO–10178-13). Dep. NTIS.

Additional information in support of the Final Safety Analysis Report is submitted under the following topics: prevention of flow reversal into anhydrous system, treatment of wastes or reworked products that may contain radioactive elements or fluoride ions, prevention against abnormal concentrations being discarded to LAW vault, rehandling of calcine, silver zeolite reactor, effects of temperature differential in calciner, process ion exchange resin disposal, effects of process computer outage, resistance of UNH calciners to pressure surges, Pu products, and provisions for removal of HF leak in storage tank. (M.C.G.)

38335 (DOCKET-50268–30) MIDWEST FUEL RECOVERY PLANT. Final Safety Analysis Report, Amendment 25. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 2 Jun 1972. 110p. (NEDO–10178-12). Dep. NTIS.

Additional information is given in support of the final safety analysis report in response to 21 AEC Staff questions. (M.C.G.)

38336 (EUR–4784) PYROCHEMICAL PRETREATMENT OF FAST POWER REACTOR FUELS: OXIDATION BY MOLTEN ALKALINE NITRATES. Avogadro, A.; De Plano, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 20 Oct 1971. 22p. (In Italian). Dep. NTIS (U. S. Sales Only). EUR FB 40,-.

The oxidation by molten nitrates of irradiated UO_2–PuO_2 allows the removal of the volatile fission products and makes the fuel easily soluble in mineral acids. This pretreatment can be carried out after a short cooling time thus reducing the inventory for the large amounts of Pu in the fast reactor fuel. Results of the laboratory experiments concerning the oxidative disgregation of the mixed oxide are reported as well as the thermal and radiolytic stability of the nitrates and the behaviour of the more significant fission products. (Euratom)

38337 (KURRI-TR-99) EXPERIMENTAL APPARATUS OF OFF-GAS TREATMENT. Kimura, Syojiro; Tsutsui, Tenson; Kanagawa, Akira (Kyoto Univ. (Japan). Research Reactor Inst.). 1972. 15p. (In Japanese). Dep. NTIS (U. S. Sales Only).

In order to investigate separation and recovery of uranium in off-gas streams discharged from uranium enrichment processes and dry chemical reprocessing, an experimental apparatus for off-gas treatment was installed. It is used for adsorption—desorption studies of UF_6 on NaF pellets and chemical engineering studies on chemical traps. Precise load cells were employed to measure continuously UF_6 weights adsorbed on NaF pellets. (auth)

38338 (MLM-1863) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: JULY-SEPTEMBER 1971. (Mound Lab., Miamisburg, Ohio). 5 May 1972. Contract AT(33-1)-Gen-53. 22p. Dep. NTIS.

The residue adsorption behavior of a high-specific-activity (HSA) source of ^{113}Sn and ^{113m}In was found to be significantly different from that of a low-specific-activity (LSA) source of the same nuclide with respect to the volatility of $SnCl_4$ and the desorption of ^{113m}In. Preparation of two ^{113m}In generators from the HSA source, one on powdered unfired Vycor and the other on silica gel, is described. The silica gel generator gave higher yields and purity of the ^{113m}In. Progress is reported on studies on a method for separating thorium-229 from uranium-233, incorporating ion exchange from nitric acid solution onto AG-50W × 12 cation exchange resin. In studies on uranium-234 recovery, a batch of uranium, containing at least 10 g of uranium-234, was treated by a double homogeneous oxalate precipitation, then by an anion exchange technique. One fraction of the uranium product solution had the plutonium contamination lowered to 1500 ppM (by weight). Studies on removing molybdenum from coated ceramic oxide particles were continued. Molybdenum can be removed from molybdenum-coated thorium dioxide by the use of aqueous solutions of hydrogen peroxide or potassium ferricyanide. Both methods remove the major portion of the molybdenum coating. The oxygen content of polyethylene containers used in neutron activation analysis was determined by comparison to data obtained from four Mylar standards. A polyethylene-container-material value of 0.77 mg was obtained for the actual sample. Nine additional randomly chosen containers were analyzed, showing a value of 0.7 ± 0.2 mg of oxygen. X-ray fluorescence techniques are being evaluated as a replacement method for the involved spectrophotometric procedure for determining thorium in plutonia. Encouraging results are presently being obtained on solid samples of plutonia containing known amounts of thorium, although precision is poor in the lower thorium concentration ranges. Additional effluent samples were taken for the determination of tritium concentration by gas proportional counting, and for the determination of the percent tritium as tritiated water. Data are given for the accuracy evaluation of determining tritium in air by gas proportional counting. (J.G.B.)

38339 SOME HIGHLIGHTS IN FUEL REPROCESSING. Lung, M. (Saint-Gobain Techniques Nouvelles, Courbevoie, France). Genshiryoku Kogyo; 18: No. 1, 7-9(Jan 1972). (In Japanese).

Several commercial plants for the fuel reprocessing are in operation, under construction, and being planned at present. However, reprocessing cost must be taken into consideration so as to be kept within a few percents of total cost because of the high reprocessing cost. Moreover, safety problems caused by a large amount of fission products produced in the plants must be solved sufficiently. From experience in the reprocessing plants, the following points are reported in this review. Common plants can be used for many types of fuel, mechanical decladding is superior to chemical, direct control is safe enough if the plants are designed carefully, remote control may be considered for cases when the direct control is impossible, large wet process will be used in the future, mixer-settler or pulse-column is used for extracting apparatus, there is no trouble in the reprocessing of high burnup fuel. Comparison between the 1st plant in Japan and other plants is described. Safety control is severe for radioactive waste concentration. Next plant must be more economical and many useful materials must be recovered from fission products. (Japan)

38340 PROBLEMS TO BE STUDIED PRIOR TO THE CONSTRUCTION OF 2nd REPROCESSING PLANT IN JAPAN. Ichimonji, Masami (Sumitomo Atomic Energy Industries, Ltd., Tokyo). Genshiryoku Kogyo; 18: No. 1, 24-9(Jan 1972). (In Japanese).

The PNC fuel reprocessing plant will start operation in about 1974. A second reprocessing plant, which is much larger in scale, is expected to be run by private industry. It is then necessary to assess capacity of the plant and time of its operation from an economic point of view. Combining the factors involved, increasing and decreasing fuel reprocessing cost, the capacity and time of beginning operation for the second reprocessing plant are evaluated. The second plant may be most economically operated at 5 tons per day, and the time of its operation is from 1982 to 1983. Problems in putting it into operation are described, including set-up of reprocessing business, and cooperation among concerned circles. (Japan)

38341 INTERACTION OF BERYLLIUM WITH MOLTEN SODIUM FLUORIDE AND UF_4–NaF SALT MIXTURES. Novoselov, G. P.; Kashcheev, I. N.; Zolotarev, A. B. This paper was summarized in At. Energ. (USSR); 30: No. 4, 383(Apr 1971) as paper No. 477/5831. (In Russian).

Full copy of this paper is held by TIC.

The interaction of beryllium with molten sodium fluoride and UF_4—NaF salt mixtures was studied. It was established that under nonequilibrium conditions, at 1000°C, metallic beryllium (0.2-g sample) reacts almost entirely with molten sodium fluoride within 30 min according to the reaction: $Be + 2NaF \rightarrow BeF_2 + 2Na$. The main cause of the reaction is evaporation of metallic sodium from the reaction zone. In the presence of an excess of sodium fluoride, the salt phase was obtained in the form of a finely divided powder. When salt mixtures, UF_4—NaF, were melted in the presence of metallic beryllium for 60 min, beryllium also reacted entirely with the salt melt, and the deposition of metallic sodium was observed. In the case of subsequent cooling of the salt solution to room temperature (rate of cooling 33 deg/min), the formation of two layers was observed. The lower layer represented a brown-colored melt and contained 96.5 to 98.7% by weight of the original amount of uranium. The upper layer was in the form of a white, readily separated powder. (auth)

ENGINEERING

Energy Conversion

Refer also to abstract 40125.

38342 (EUR–4776) HYDROGEN PRODUCTION FROM WATER USING NUCLEAR HEAT. Progress Report No. 1, Ending December 1970. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 5 Jan 1971. 78p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 100.-.

Multistep chemical processes for the decomposition of water, using nuclear heat, are studied in view of producing hydrogen as an intermediate energy vector. The results of the work performed at the Ispra Center up to December 1970 are reported: the main object of the research is the Mark-I cycle, the first patented chemical cycle. The studies are principally related to the chemistry (equilibria and kinetics studies and physiochemical properties), to the corrosion of construction materials, to the preliminary flowsheet determination for the coupling with a nuclear reactor. A general hydrogen market evaluation is also included. (auth)

38343 (TEE–3056-1) TRANSPORT PHENOMENA IN A PLASMA DIODE. Clark, M.; Keck, J. (Thermo Electron Corp., Waltham, Mass.). Sep 1971. Contract AT(11-1)-3056. 224p. (TE–4137-90-72). Dep. NTIS.

A technique is described for use in developing the theory of the ignited mode in thermionic converters which, while providing relatively simple analytic forms for the solutions, preserves the features observed in the computer analyses. The results provide a reasonably simple method for calculating dependence of the converter J-V characteristics on various parameters and with further development could be used for design calculations. In the plasma, as the pressure spacing product is reduced and the various particle mean-free paths approach the dimensions of the plasma width, the quasi-equilibrium condition may no longer be valid. In additive converters, which characteristically operate at low cesium pressures, such conditions can occur at spacings of practical interest. The analysis must then include the transition region between the sheath and the quasi-neutral plasma. At smaller spacings, there may be no quasi-neutral region at all. Within the transition region, the collision processes must be added to the analysis and new boundary conditions determined from the behavior of the particles. These solutions may then be used to determine the extent of the validity of the quasi-equilibrium solutions. Research is also reported which is devoted to the analysis of the sheath and transition regions of the converter. The simple collisionless sheath approximation is examined; it proved to be incapable of satisfying all the required boundary conditions. With collisions occurring within the sheath, the shape of the particle and potential distributions must be known to define the plasma boundary conditions properly. This is particularly true in the case of non-monotonic potential distributions where the height of the barrier is determined by the sheath phenomena. By using an integral method to find solutions for the Boltzmann equation, it was possible to obtain rapid convergence without encountering severe instabilities. (J.R.D.)

38344 (UCRL–73560) MATERIALS PROBLEMS IN DIRECT CONVERSION SYSTEMS. Werner, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). 24 Apr 1972. 37p. (CONF-720515–4). Dep. NTIS.

From fourth annual spring meeting of the Metallurgical Society of AIME; Boston, MA. (8 May 1972).

Some of the potential problems of a materials-metallurgical-chemical nature which may arise in fusion reactors utilizing the magnetic mirror principle and direct conversion of charged particle energy to electricity are enumerated. The effect that the energetic particles, charged or neutral, may have on three main components is discussed. These components are: the first wall; the blanket; and the collector elements of the direct converter. The complexity of problems in these areas is enumerated and some possible solutions offered which are considered worthy of further investigation. (auth)

38345 CONVERTER FOR THE CONVERSION OF HEAT TO ELECTRICAL ENERGY. Lavigne, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,271,046. 19 Apr 1972. Priority date 27 Nov 1969, France.

Equipment for conversion of heat to electric energy is described that uses a fluid in a circulation loop system approximating an Ericsson cycle. Heat generated by a thermal source is converted to alternating current energy. (J.R.D.)

38346 RADIONUCLIDE ENERGY CONVERTER. (to Centre Technique de l'Industrie Horlogere). French Patent 2,067,890. 26 Jul 1971. Filed 20 Nov 1969. (In French).

A converter for converting the energy of a radionuclide into mechanical or electrical energy is described. The kinetic energy of the particles emitted by a radionuclide is used to produce a periodically varying potential across the terminals of a capacitor. This potential is applied to a transducer, which controls the motion of a mobile device. The energy is obtained either directly (mechanically) from the mobile device, or in electrical form by means of a transducer. The motion may be an oscillation or a continuous rotation. The converter is a radiodiode, consisting of an electrode coated with the radionuclide and at least one facing electrode. One of the electrodes is mobile so that the interacting electrode area is variable. An ac current is generated, which corresponds to the frequency of the movement. (France)

38347 MHD GENERATOR ELECTRODE INSENSITIVE TO THE ACTION OF AN ALKALINE SEED. Blattmann, Henri; Javellaud, Jean; Yerouchalmi, David (to Commissariat a l'-Energie Atomique). French Patent 2,082,734. 15 Nov 1971. Filed 25 Mar 1970. (In French).

A composite-electrode magnetohydrodynamic generator in which the ceramic parts are unaffected by corrosion due to the molten alkaline seed collecting in zones at temperatures near to the melting point of this seed is described. It consists of identical principal elements consisting of several elements of a particular type, the back ends of which are constructed of Cu and cooled by circulating water. The outsides of the principal elements of the electrodes are heated everywhere, to a temperature which is at least 50°C higher than the vaporization temperature of the alkaline seed. Stainless steel elements are used for the sides of the principal elements, which are in contact with hot gases; two types of ceramic elements form the central part of the principal elements: those of ZrO_2 and $LaCrO_3$ serving as current collectors; those of MgO and $SrZrO_3$ serving as heat insulators. (France)

38348 CHARACTERISTICS OF AN ELECTROGASDYNAMIC MOTOR. Bortnikov, Yu. S.; Nesterov, V. A.; Rubashov, I. B. Zh. Prikl. Mekh. Tekh. Fiz.; No. 6, 167-70(Nov-Dec 1971). (In Russian).

Results are given from a theoretical and experimental investigation of an electrogasdynamic motor designed for propelling aircraft. Calculated values agree with those from experiment. The effectiveness of EGD motors may be sufficiently high for practical application. (tr-auth)

38349 APPLICATION OF THE TWO-PORT NETWORK THEORY TO THE ANALYSIS OF THE FARADAY- AND HALL-TYPE MHD GENERATORS. Celinski, Zdzislaw. Arch. Elektrotech. (Warsaw); 21: No. 1, 141-58(1972). (In Polish).

From the electrical point of view, the element of generator channel with one pair of electrodes may be considered as two-port electrical network. Based on the theory of such networks, the equivalent circuit of the ideal generators may be found and their electrical parameters may be determined. This method may be also applied to the analysis of the real generators, i.e., to the generators with the electrodes of finite length, with the leakage currents and with the nonuniform gas parameters between the opposite electrodes. (auth)

38350 CALCULATION OF THE PARAMETERS OF A PLASMA OF PURE INERT GASES FOR A NONEQUILIBRIUM MAGNETOHYDRODYNAMIC GENERATOR. Goryachev, V. L.; Remennyi, A. S. High Temp. (USSR) (Engl. Transl.); 9: No. 5, 959-64(Sep-Oct 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 5, 1056-61

Results are presented of calculations of the electrical conductivity, electrical efficiency, and specific power for a plasma of pure inert gases with application to a nonequilibrium closed-cycle magnetohydrodynamic generator. (auth)

38351 STUDY OF THE U-02 MHD INSTALLATION UNDER CONDITIONS OF PROLONGED CONTINUOUS WORKING. Kirillin, V. A.; Sheindlin, A. E.; Shumyatskii, B. Ya.; (and others) (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 5, 937-50(Sep-Oct 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 5, 1029-46 (Sep-Oct 1971).

The principal results of some experimental investigations into the working characteristics of the complex power installation U-02 (incorporating an MHD generator) carried out during 1965 to 1971 are presented. These investigations were based on the continuous long-term operation of the installation. The possibility of heating air stably to 1500 to 2000°C in a high-temperature regenerative air heater with a fixed sphere-type checker and a valve-type gas distributor was verified experimentally. The construction of the combustion chamber is described, together with the results of tests carried out at gas temperatures of up to 2650°C. Problems relating to the introduction and extraction of the ionizing additive are considered. The results of tests on a multiple-element inverter system based on silicon transistors are presented. The principal results of investigations into individual parts and units of MHD power generators operating for long periods are given. Data are obtained relating to the operation of the ceramic and metallic (water-cooled) electrodes for current densities of several A/cm^2, and various forms of electrically-insulating walls under boosted conditions. (auth)

38352 EXPERIMENTAL INVESTIGATION OF NONEQUILIBRIUM EFFECTS IN A MAGNETOHYDRODYNAMIC GENERATOR. Buznikov, E. A.; Vanin, V. E.; Kirillov, V. V.; Sokolov, Yu. N. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 9: No. 5, 951-8(Sep-Oct 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 5, 1047-55 (Sep-Oct 1971).

Preliminary results of an experimental investigation of a nonequilibrium magnetohydrodynamic generator operating on argon-potassium plasma are presented. The investigations were carried out in the argon temperature range $T_g = 1100$ to 2200°K, and in the range of Hall numbers $\beta_e = 2$ to 25. It was shown that along with ionizational instability, the generator characteristics may be substantially affected by other factors which are not connected with the nonequilibrium nature of the plasma—in particular the nonideal nature of the insulation in the channel. A large positive influence of the initial plasma ionization created by the preionizer on the generator characteristics was noted. It was shown that for small dimensions of the channel and moderate induced electric fields, the departure of the electron temperature from the temperature of the neutrals is limited by the yield of radiation from the plasma volume. The calculated estimates of the excess of electron temperature which were carried out with allowance for the radiation yield are in good agreement with experimental data. (auth)

38353 AVERAGING OF THE PRESSURE AND TEMPERATURE OF A GAS FLOW WITH RESPECT TO THE COOLED SURFACE OF THE CHANNEL OF A MAGNETOHYDRODYNAMIC GENERATOR. Osadchii, V. K.; Shchegolev, G. M. Vop. Tekh. Teplofiz.; No. 3, 84-7(1971). (In Russian).

During an engineering analysis of the channels of a magnetohydrodynamic generator, the necessity appeared for consideration of the changes of both the electrical characteristics and of the gasdynamic parameters of the plasma flow along the channel. In order to obtain reliable data, the channel is ordinarily divided into separate parts, an increase in the number of which increases the precision of the analysis but leads to its complication. It is possible to reduce the analysis (mechanical or "manual") by the introduction of mean integral parameters which make it possible to obtain a given precision with a smaller number of analyzed parts. In the extreme case, it is possible to perform such averaging for the channel as a whole. An attempt was made to determine the mean integral values of the pressure and temperature. As an argument by which averaging of the plasma parameters P and T was performed, a surface of the channel f was selected owing to the fact that averaged magnitudes are necessary for an analysis of the heat exchange between the plasma and a wall which has a constant temperature. (JPRS)

38354 OPERATION OF MHD GENERATORS INTO THREE PHASE NETWORKS. Krutikov, K. K. (Moscow Energetics Inst.). Elec. Technol. (USSR) (Engl. Transl.); 2: No. 4, 17-30 (1971).

Translated from Elektrichestvo; 2: No. 4, 34-40(1971).

Electrical and thermodynamic parameters are closely interrelated when a dc magnetohydrodynamic generator is operating into a three phase network through an inverter. Functional relations are proposed for the power being inverted and cos ϕ with arbitrary relations between the control parameters, for use in experimental developments. (auth)

Facilities and Equipment

Refer also to abstract 39113.

38355 (AECL-4145) AN ANALYSIS AND OPTIMIZATION OF GEOMETRY FOR POCKET AND ORIFICE-TYPE HYDROSTATIC FACE SEALS. Metcalfe, R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1972. 29p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Axisymmetric, constant viscosity, laminar flow between parallel faces of pocket and orifice-type hydrostatic face seals is investigated theoretically. Equations for pocket pressure, leakage, balance ratio, axial stiffness, and tilting stiffness are derived in terms of eight input variables. Calculation by computer for permutations of these input variables is described. Geometrical optimization of this type of face seal is discussed. The problem is shown essentially to reduce to choice of pocket position and orifice coefficient for minimum leakage and maximum stiffness at a given value of face separation. Curves representing this optimization for a specific seal are presented. Optimum design lines are compared for two values of applied pressure and three different face separations. It is shown to be of benefit to operate with the minimum practical face separation consistent with prevention of distortion effects or orifice blocking. (auth)

38356 (CONF-710839-1) ANALYSIS OF THICK-WALLED PRESSURE VESSELS USING THE CONSTANT STRAIN AXISYMMETRIC FINITE ELEMENT. Riikonen, Ilkka (Helsinki Univ. of Technology, Otaniemi (Finland)). [nd]. 10p. Dep. NTIS (U. S. Sales Only).

From fourth Nordic symposium on the strength of materials; Otaniemi, Finland (5 Aug 1971).

Practical solutions obtained using a digital computer program that applies the two dimensional axisymmetric element of six degrees of freedom to the analysis of shells of revolution are discussed. The automatic generation of the element mesh for torispherical drum heads, the calculation of stress resultants at the surface of the wall, the effect of singularity, and numerical integration to the global and local stiffness matrixes are surveyed. (auth)

38357 (LA-DC-72-228) COMPUTER CONTROLLED ELECTRON BEAM WELDING FACILITY AT LASL. Brundige, E. L. (Los Alamos Scientific Lab., N. Mex.). [1972]. Contract W-7405-eng-36. 9p. (CONF-720322-1). Dep. NTIS.

From IMOG joining subgroup meeting; Aiken, SC, (21 Mar 1972).

A direct numerical control (N/C) system is described which incorporates the reliability and repeatibility strong points of the conventional N/C system involving the control of electron gun motion true to part parameters and weld setting plus the inherent potential for storage of several part programs available for instant recall by the operator to allow quick changes from one part to another. The DNC system has the potential for various types of adaptive control systems to be incorporated into the basic overall control system. All the flexibility that can be incorporated into a general purpose computer system is available to the computer-based electron beam control system. (auth)

38358 (NP-19297) ANNUAL RESEARCH SUMMARY, 1971. (Purdue Univ., Lafayette, Ind. School of Electrical Engineering). 205p.

Research progress is reported on automatic controls, bioengineering, circuits and systems, communication science, computers and automation, electromagnetic fields, energy sources and systems, and solid state devices and materials. Abstracts of Ph. D. dissertations are included along with lists of 1971 publications. (J.R.D.)

38359 (RDT-E-1-35-T(5-72)) INERT GAS VALVES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 29p. RSO.

A standard prescribing requirements for inert gas valves for nuclear and associated applications is presented. (J.R.D.)

38360 EFFECTIVE LENGTH OF THE RADIOMETRIC DENSITY METER PROBE. Zvol'skii, S. T. (Inst. of Geological Sciences, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 1, 38-41(Jan 1972). (In Ukrainian).

A separating screen for the radiometric density meter probe, besides its direct purpose, has an essential influence on the effective length of the probe. The basic distance of the probe being one and the same, the effective length of the probe can be changed by the separating and collimating screens in the necessary direction. In post-inversion probes of optimum length dislocation of an additional separating screen from the source side provides an almost 3-fold increase in the probe relative sensitivity to density. In pre-inversion probes collimation of the source γ-radiation produces an almost 2-fold increase in their relative sensitivity. (auth)

38361 ANISOTROPIC HEAT VALVE. (to Sanders Nuclear Corp.). British Patent 1,271,252. 19 Apr 1972. Priority date 17 Jun 1968, United States.

A heat valve for use in interconnecting a thermal source and a heat user to regulate flow of heat from the source to the user is described. The valve comprises a housing and an anisotropic member associated with the housing having heat conductivity in one direction higher than heat conductivity in a second direction. A means is provided for pivoting the member with respect to the path between the source and the user to change the rate of heat flow through the member. The anisotropic member is pyrolytic graphite in the form of a cylinder, the outer surface of which directly contacts the inner surface of the housing at least on two opposed sides. Rotation of the cylinder about its axis effectively changes the thermal conductivity of the valve in one direction from one side to the other by a factor of at least 100. The heat valve has few parts and can be easily fabricated from inexpensive materials. Positive heat regulation can be provided in wide number of applications. (J.R.D.)

38362 HIGH VOLTAGE CONNECTOR FOR A NEUTRON GENERATOR COMPRISING A PLASTIC INSULATOR. Langford, Obie M. (to Texaco Inc.). U. S. Patent 3,657,536. 18 Apr 1972. Filed 29 Jan 1970.

A high voltage connector apparatus for a radioactivity well logging tool includes a solid conductor axially located within a molded Teflon insulator. The insulator has a smooth transverse face acting as an end wall for a high pressure gas-containing section of the tool. (Offic. Gaz.)

38363 EFFICIENCY MEASUREMENT OF MIXING DEVICES BY A RADIOTRACER TECHNIQUE. Breda, M.; Krysta, Z. (Vyzkumny Ustav Pozemnich Staveb, Prague). Radioisotopy; 13: No. 1, 177-204(1972). (In Czech).

A method of measurement of the efficiency of industrial mixing devices with discontinuous operation using radioactive tracers is described. Measurements of the homogeneity of concrete mixtures were performed for an automixer of Czechoslovak production, type AM-5 with free mixing, and for a concrete mixer with forced mixing from the Waimer, GFR firm. (auth)

38364 HYDRAULICALLY ACTUATED VALVE FOR VERY LOW TEMPERATURES. Roach, Pat R.; Ketterson, J. B.; Kuchnir, M. (Argonne National Lab., Ill.). Rev. Sci. Instrum.; 43: No. 6, 898-9(Jun 1972).

In order to seal off an experimental cell containing liquid He at temperatures down to 20 mK and at pressures up to 25 atm we have developed a valve that is actuated hydraulically by liquid He and which seals repeatedly with a leak rate of less than 10^{-10} cm^3/sec of liquid He II. (auth)

38365 IRRADIATION APPARATUS. (to High Voltage Engineering Corp.). British Patent 1.277,253. 7 Jun 1972. Filed 13 Oct 1969.

Reference is made to apparatus and methods for the high-energy electron irradiation of materials, and particularly materials in sheet or film form, such as in the irradiation polymerization of plastic coatings. The method described is stated to result in ensuring adequate uniform irradiation and increased efficiency. The coated material is moved along a path that intersects the beam of high energy electrons at an oblique angle such that the radiation penetrates to the bottom of the coating layer and substantially all the electron energy is absorbed by the coating. (UK)

38366 CONTINUOUS FURNACE FOR SINTERING. Aubry, Bernard; Gillot, Jacques; Masselot, Yves; Teboul, Albert (to Commissariat a l'Energie Atomique). British Patent 1,276,229. 1 Jun 1972. Priority date 8 Aug 1969, France.

A furnace is described for continuous on-line sintering of ceramic nuclear fuel pellets in neutral or reducing atmosphere. The furnace is in the shape of a tunnel having a pre-sintering zone and a sintering zone. Containers for the pellets are moved through the furnace along a support plate. Provisions are made for furnace atmosphere control and control of pellet binder materials. (J.R.D.)

38367 ANALYTICAL DETERMINATION OF FREEZE-SEAL STEM LENGTH FOR SODIUM COMPONENTS. Cho, S. M. (Liquid Metal Engineering Center, Canoga Park, Calif.). Nucl. Sci. Eng.; 48: No. 3, 353-8(Jul 1972).

An analytical method is presented for accurate determination of the length of a freeze-seal stem for use in sodium components. The analysis is directly applicable to a vertical stem with longitudinal fins that is cooled by natural or forced convection and thermal radiation. The method can be readily extended to other geometrical systems. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 38361, 38367, 38432, 39757, 40208, 40386, 40387, and 40456.

38368 (EUR-4771) STUDY OF THE EXCITATION OF HYDRODYNAMIC VIBRATIONS IN A SIMPLE ROD MODEL IN PARALLEL WATER FLOW. Ohlmer, E.; Russo, S.; Schwemmle, R. (European Communities, Brussels (Belgium). Commission. European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Mar 1972. 50p. (In German). Dep. NTIS (U. S. Sales Only). EUR BF 70,-.

An analytical model for parallel flow-induced vibrations was experimentally checked on a single rod test facility in a water loop. Especially, the influences of simplification hypothesis in the analytical model and of loop-caused disturbances in the flow were considered. The tests show that the analytical model is useful also for application in the case, that pump or valve-induced noise is present in the flow. Furthermore, it has been seen that the simplifying assumption of an "homogeneous pressure field" over the beam length tends to overestimate the exciting pressure forces. Measurements of the pressure-difference-fluctuations on the rod surface have given some results for characterizing the pressure field in the present flow geometry, both for undisturbed established flow and for the flow in the entrance zone. External noise in the flow, e.g., induced by circulation pumps, can increase by an important factor the pressure differences and corresponding rod vibrations. The actual study will continue with similar tests on a rod-bundle geometry. (auth)

38369 (INR-1384) COMPUTER SUBROUTINES FOR CALCULATING PHYSICAL AND THERMODYNAMICAL PROPERTIES OF WATER AND STEAM. Kulig, Maciej (Institute of Nuclear Research, Warsaw (Poland)). 1972. 23p. (In Polish). Dep. NTIS (U. S. Sales Only).

Computer subroutines for calculating physical and thermodynamic properties of water and steam are presented. These subroutines can be used in calculating power plant cycles, steam generators, heat exchangers, and steam turbines. The results of error analysis and application conditions are included. (auth)

38370 (RT/ING-(71)9) FORCED CONVECTION HEAT TRANSFER AND BURN-OUT MEASUREMENTS WITH TWISTED TAPES. Brevi, R.; Cumo, M.; Palmieri, A.; Pitimada, D. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 24 Mar 1971. 34p. Dep. NTIS (U. S. Sales Only).

Very promising results obtained by Lopina and Bergles with the insertion of twisted tapes in tubular heat exchangers have suggested experimentation in more interesting conditions, i.e., higher pressures ($p = 50$ atm) and larger geometries ($L = 200$ cm and $I.D. = 1$ cm). The results show very great increases of the forced convection heat transfer coefficient, ranging from 200 to 250% with specific mass flowrates from 70 to 110 g/cm^2 sec. The law of dependence of the Nusselt number on the Reynolds number varies, with an exponent of 1.0 instead of 0.8. The burnout thermal power increases from 30 to 50%; correspondingly the burnout qualities increase from 60 to 90%, thus drastically reducing the post-burnout length. Furthermore, in this length there are no longer the characteristic, dangerous temperature oscillations. (auth)

38371 EXPERIMENTAL STUDY OF FORCED CONVECTION HEAT TRANSFER AT ELEVATED FLUX WITH WATER AT HIGH SPEED IN A SMALL DIAMETER TUBE, WITH AND WITHOUT BOILING. Ricque, R.; Siboul, R. (CEN, Grenoble, France). Int. J. Heat Mass Transfer; 15: No. 4, 579-92(Apr 1972). (In French).

A description is given of the apparatus and the experiments for determining the laws of heat transfer with and without local boiling as well as the laws of friction without local boiling in tubes of 2 and 4 mm inner dia., heated with a uniform flux and in which water flows at high velocities. The empirical laws obtained agree in general with the classical laws established in ordinary conditions. (auth)

38372 DROPLET INTERCHANGE MODEL FOR ANNULAR-DISPERSED, TWO-PHASE FLOW. Moeck, E. O. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Stachiewicz, J. W. Int. J. Heat Mass Transfer; 15: No. 4, 637-53(Apr 1972).

An analysis of annular-dispersed flow is presented in which the flow is modelled as a two-dimensional film and a one-dimensional, droplet laden gas core. The focus of the analysis is droplet interchange between core and film and its associated momentum transfer. The intensity of droplet deposition and entrainment governs the axial velocity of each drop size and allows calculation of a maximum stable drop diameter, in good agreement with Wicks' measurements. An exponential radial void distribution together with a modified universal velocity profile through the film allow calculation of mean and film crest thicknesses from a given film flow rate. These agree well with Harwell data as does the calculated film crest velocity. Interfacial friction factors due solely to profile drag are also calculated and found to agree approximately with Wallis' values for flows with negligible entrainment. (auth)

38373 EFFECT OF FREE CONVECTION ON THE CONDUCTIVITY OF A VERTICAL BED OF POROUS INSULATION. Betbeder, J.; Jolas, P. (Electricite de France, Chatou). Int. J. Heat Mass Transfer; 15: No. 4, 721-32(Apr 1972). (In French).

The thermal properties of a porous insulation in a high pressure gas deteriorate when the pressure increases. The convective heat transfer adds to the conduction heat exchange playing an increasingly more important role as the pressure gets higher. The effect of convection on the behavior of the insulation was observed by examining a simple case: the heat transfer between two vertical walls of a parallelipiped cell containing a porous medium saturated with a high pressure gas. The walls of the cell were sealed. The study consisted of numerical calculations and thermal tests using stainless steel wire gauze packs in carbon dioxide gas. The numerical results agreed with the tests and it was shown that for a cell of given aspect ratio the convection effects could be observed above a certain value of the Rayleigh number. Two important parameters which appear in the Rayleigh number, i.e., thermal conductivity without convection and permeability, characterize the thermal insulation. (auth)

38374 HEAT TRANSFER BY CONDENSATION OF LOW PRESSURE METAL VAPORS. Huang, Y. S.; Lyman, F. A.; Lick, W. J. (Case Western Reserve Univ., Cleveland). Int. J. Heat Mass Transfer; 15: No. 4, 741-54(Apr 1972).

The film condensation of low-pressure metal vapors on isothermal vertical flat plates or tubes is considered. The liquid film is treated as a thin layer in which the acceleration and pressure forces are negligible and across which the temperature distribution is linear. The average behavior of the vapor is found from the linearized one-dimensional vapor flow equations. In order to calculate the rate of condensation, a consistent distribution function for the vapor particles at the liquid—vapor interface is determined. The result of the analysis is a set of algebraic equations from which the condensation rate of low pressure metal vapors can be predicted. A large but continuous temperature decrease in the vapor is predicted and calculated. There is good agreement between the most recent experimental data and the calculations if, in the calculations, the presence of a small amount of a non-condensible gas is included. (auth)

38375 HEAT-TRANSFER MECHANISMS IN NUCLEATE AND FILM BOILING. Tong, L. S. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Des.; 21: No. 1, 1-25(1972).

Boiling mechanisms at various flow conditions are described and verified heat-transfer correlations for water are provided. Emphasis is given to the prediction of incipient nucleate boiling, effect of surface fouling, and transient cooling. The objective of the correlations and predictions is the efficient design of nuclear reactor boiling equipment, i.e., steam generators and effective core safeguard cooling systems. (auth)

38376 DYNAMICS OF NUCLEATE BOILING. Peterson, W. C.; Zaalouk, M. G.; Mitry, A. M. (North Carolina State Univ., Raleigh). Nucl. Eng. Des.; 21: No. 1, 26-34(1972).

A transfer function believed to describe the dynamics of pool boiling heat transfer was developed analytically. A feedback system for control of the heater surface temperature was then designed and very successfully operated. It thus became possible to experimentally test the validity of the analytical transfer function. Tests on the controlled heat-transfer process indicated that agreement between predicted and experimental results was good only in the film boiling region. It was concluded that a time delay was involved in the bubble-formation process during nucleate boiling. Taking this time delay into account, a better agreement between predicted and experimental results was obtained. (auth)

38377 EVALUATION OF NUCLEATE BOILING HEAT FLUX PREDICTIONS AT VARYING LEVELS OF SUBCOOLING AND ACCELERATION. Judd, R. L. (McMaster Univ., Hamilton, Ont.); Merte, H. Jr. Int. J. Heat Mass Transfer; 15: No. 5, 1075-96(May 1972).

The heat flux predictions of six different models proposed to explain the nucleate boiling phenomenon are compared with the corresponding heat flux measurements at the same levels of subcooling and acceleration. It is shown that none of these models can adequately predict nucleate boiling heat flux for other than saturated boiling conditions at standard gravity and that all of the models agree in predicting decreasing values of heat flux as subcooling and acceleration increase. This observation suggests the omission of some additional mechanism which is inoperative under saturated boiling conditions at standard gravity but very sensitive to the level of subcooling and acceleration. An empirical procedure is presented for correlating the results used in making the comparisons. (auth)

38378 INFLUENCE OF WALL THICKNESS, THERMAL CONDUCTIVITY, AND METHOD OF HEAT INPUT ON THE HEAT TRANSFER PERFORMANCE OF SOME RIBBED SURFACES. Barnett, P. G. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). Int. J. Heat Mass Transfer; 15: No. 5, 1159-69(May 1972).

The average heat transfer coefficient of a surface can be increased by adding turbulence promoters. Use of such devices produces a non-uniform distribution of heat transfer coefficient over the surface. Consequently factors affecting the ease with which heat can reach the areas of high heat transfer coefficient will affect the distribution of surface temperature; examples are the thickness and thermal conductivity of the material forming the surface and the method of heat input. Using a computer program to solve the heat conduction equation the magnitude of these effects was assessed for surfaces having transverse ribs. The results showed that the performance of geometrically identical surfaces, as judged by the peak surface temperature, for example, may differ significantly. The implication was that such factors must be taken into account when, for example, experimental data obtained for a ribbed surface on a thick walled aluminium can are used to predict the peak surface temperature in a reactor of a geometrically similar surface on a thin walled can made of stainless steel. (auth)

38379 SELECTING MAGNITUDES OF CRITICAL HEAT FLUXES WITH WATER BOILING IN VERTICAL UNIFORMLY HEATED TUBES. Doroshchuk, V. E.; Lantsman, F. P. Therm. Eng. (USSR) (Engl. Transl.); 17: No. 12, 18-21(1970).

Translated from Teploenergetika; 17: No. 12, 17-19(1970).

An attempt is made to explain discrepancies in published experimental results on burnout (or critical) heat fluxes with water boiling in uniformly heated vertical tubes. It is contended that these discrepancies are caused by not taking into consideration both pressure and flow rate fluctuations which occur in the experimental flow circuit. These fluctuations are said to be caused by condensation of the inlet steam—water mixture before it reaches the test section and by the formation of steam—water again at the outlet of the test section. When experimental data published in world literature was analyzed and these flow and pressure fluctuations were considered, the values of critical heat flux found agreed within 10 to 15%. (L.C.L.)

38380 SINGLE- AND TWO-PHASE PRESSURE DROPS ON A 6 x 6 ROD BUNDLE AT 70 ATM. Grillo, P.; Mazzone, G. (Comitato Nazionale Energia Nucleare, Rome). Nucl. Technol.; 15: No. 3, 25-35(Jul 1972).

Pressure drop measurements were carried out with single- and two-phase flow at 70 atm through a 6 × 6 fuel rod bundle. Single-phase measurements were performed with subcooling ranging from 100 to 5°C and at mass velocities between 0.5×10^6 and 3.3×10^6 lb/hr ft^2. Two-phase measurements were performed at steam qualities ranging from 3 to 20% and at mass velocities comprised between 0.5×10^6 and 2×10^6 lb/hr ft^2. From the measured pressure drops, the bundle friction factor and the loss coefficient for each bundle component (bottom plate, spacer and upper plate) were determined. Single-phase results show that Moody's curve for friction losses and Kay's coefficients for form losses, lead to predicted pressure drops in good agreement with the experimental ones. The two-phase loss coefficients of the spacer and the bottom plate were compared to the slip model prediction. If, for each component, an ad hoc choice of the slip ratio is made, the calculated values can be matched to the experimental ones with good accuracy. In addition, two-phase friction losses have been calculated on the basis of the Martinelli-Nelson, Becker and Baroczy correlations with a resulting good agreement between the predictions of the last correlation and the experimental data. (auth)

Materials Testing

Refer also to abstracts 38344, 38466, 38588, 38934, and 38981.

38381 (CEA-CONF-1949) DESCRIPTION OF NEUTRONOGRAPHIC INSTALLATIONS: REACTOR NEUTRONOGRAPHY IMMERSED INSTALLATIONS, INDUSTRIAL INSTALLATIONS, AND PARTICULAR APPLICATIONS). Perves, J. P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 27 Sep 1971. 23p. (In French). (CONF-711134-1). Dep. NTIS (U. S. Sales Only).

From Conference on defectoscopy, Prague, Czechoslovakia (8 Nov 1971).

The CEA reactor neutronography installations are briefly described. The immersed installations are used for the high-flux irradiation of materials near the core of the reactor. The difficulties of manipulating samples under several meters of water made this method unsuitable for industrial uses. The industrial installations at Triton and Siloette are described. Special installations for energy selection of neutrons are also discussed. (J.S.R.)

38382 INDUSTRIAL APPLICATION OF NEUTRON RADIOGRAPHY USING A LOW-INTENSITY SOURCE. Hawkesworth, M. R.; Peters, R. E. (Birmingham Univ., Eng.). Brit. J. Non-Destruct. Test.; 14: No. 3, 87-8(May 1972).

The nondestructive testing of plate assemblies has been successfully accomplished at Rolls-Royce Ltd. using a beam of thermal neutrons from a small water moderated americium—beryllium neutron source. The first series of plates was tested in May 1966, and this is believed to have been the earliest application of neutron radiography to industrial testing on a routine basis. (auth)

38383 ELECTRON DEFECTOSCOPY USING CHERENKOV DETECTORS. Kononov, B. A.; Zykov, V. M. (Tomsk Polytechnic Inst., USSR). Defektoskopiya; No. 6, 58-62(1971). (In Russian).

Increase of the sensitivity of spectrometric and ionization methods of electron defectoscopy by a factor of 3 and 1.5, respectively, were shown possible with the use of Cherenkov detectors. The latter are selected (solid, liquid, or gas) with a refractive index which assures a discrimination threshold of electrodes according to the energy of the high-energy portion of the radiation spectrum passing through the product being controlled. (tr-auth)

38384 DEFECT SIGNAL SHAPE IN SCINTILLATION GAMMA-DEFECTOSCOPES. Gorbunov, V. I.; Shchetinin, Yu. I. (Tomsk Polytechnic Inst., USSR). Defektoskopiya; No. 6, 44-50 (1971). (In Russian).

Functions of ray contrast of a defect and the detector sensitivity were discussed for scintillation defectoscopes having clear physical representation. Within the framework of the theory of linear systems a general expression was obtained which described the signal shape for a defect in the regions of frequency and time. Recommendations as to parameters are made which establish quick response in a defectoscope. (tr-auth)

38385 EXO-EMISSION DEFECTOSCOPY OF DEFORMED SURFACES OF MATERIALS. Alimov, V. I.; Melekhin, V. P.; Mints, R. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Defektoskopiya; No. 6, 50-3(1971). (In Russian).

Equipment for recording "emission topography" of materials being subjected to mechanical deformation is described. Horizontal and vertical displacements of a light beam from a Hg arc lamp are separately recorded, the sample being enclosed in a vacuum system at 10^{-6} torr. Scanograms which reveal the surface contours of an aluminum sample are reproduced. (K.S.W.)

38386 NEUTRON RADIOGRAPHY. Spowart, A. R. (Paisley Coll. of Tech., Scotland). J. Phys., E (London); 5: No. 6, 497-510(Jun 1972).

The nondestructive testing technique of neutron radiography is reviewed, and in particular the industrial applications are emphasized which are at present in use and which are foreseen in the near future. Applications in the fields of nuclear reactor technology, aerospace and medicine are illustrated in radiographs from a selection of the operating laboratories in the UK and USA. The projected growth of the technique is discussed. (auth)

Nuclear Explosions

Refer also to abstracts 38427, 38542, and 38554.

38387 (BMI-171-145) AMCHITKA BIOENVIRONMENTAL PROGRAM. LIMNOLOGY OF AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1970–June 30, 1971. Birch, Thomas J. (Battelle Columbus Labs., Ohio). Apr 1972. Contract AT(26-1)-171. 43p. Dep. NTIS.

Limnological investigations on Amchitka Island, Alaska, were conducted during Fiscal Year 1971 to assess the nature and magnitude of effects on chemical, physical, and biological parameters to fresh-water ecosystems resulting from Milrow on October 2, 1969, and study selected freshwater ecosystems in order to form a basis for predicting and evaluating the nature and magnitude of the effects of Cannikin, an underground nuclear test proposed for FY 1972. No major alterations to lakes and ponds on Amchitka resulting from Milrow were observed during FY 1971. No significant alteration in water level occurred during the year in any of the lakes studied. The absence of significant increases in alkalinities in study lakes indicates that alkaline subsurface bedrock has not been exposed to any great degree by rupturing of the overlying peat mat in the drainage basins of these lakes. Data collected on lakes in the Rifle Range Point area suggest that subtle shifts in chemical and biological parameters have occurred and are probably related to Milrow. These changes are expected to be of limited duration in the absence of further perturbations to their drainage basins. Data collected on Round Lake suggest that the short-term post-Milrow changes in water chemistry and zooplankton populations observed on that lake were probably seasonal and not the result of Milrow. Observations indicate that Strange Pond is rapidly recovering from increased alkalinity concentrations resulting from test-related activities. Emerald Lake has been drastically altered in chemical, physical, and biological parameters as a result of drill mud entering the lake. Recovery of this lake is expected to be very slow by comparison to that for Strange Pond. During the autumn sampling, alkalinities in the Cannikin survey lakes tended to decrease while pH values tended to increase. Zooplankton communities were dominated by rotifers and were tending to decrease in number. Population crashes during this period were observed in several lakes. Preliminary results of studies on the effects of severe mixing of water in lake basins near SZ site by wind action suggest that these conditions may result in changes in pH and alkalinity but no drastic changes to zooplankton populations were observed. (auth)

38388 (EERO-39) REVISED EMPIRICAL APPROACH TO AIRBLAST PREDICTION. Snell, Charles M.; Oltmans, Dennis L. (Army Engineer Explosive Excavation Research Office, Livermore, Calif.). Nov 1971. 120p. Dep. NTIS.

Airblast from buried chemical and nuclear detonations has been under systematic investigation for two decades. There now exists a sizable body of information collected during field experiments conducted over the years. A summary compilation of the available data for all significant large-yield events is presented and these data are synthesized into an empirical prediction method. Since the airblast from buried detonations approaches a consistent attenuation at the longer ranges of interest for safety predictions, a purely empirical "transmission factor" analysis based on consistent longer range data from subsurface detonations is used. Transmission factors are established as functions of scaled depth of burst for a variety of media and types of explosives. These are used to predict both ground-shock and gas-vent airblast from single- and row-charge detonations. A new approach to predicting the close range overpressures is also discussed. A summary of airblast from surface bursts is included. The empirical prediction method presented is well-founded for those types of events which have been extensively investigated. Its chief weakness lies in the prediction of dissimilar events (different yields, explosive types, or media) for which there are insufficient data. (auth)

38389 (PNE-R-59) POST-SHOT ACTIVITIES AND PROGRAMS. PROJECT RULISON. Summary Report. (Austral Oil Co., Inc., Houston, Tex.). Apr 1972. 12p. Dep. NTIS.

The activities and programs concerning post-shot investigations of the Rulison Event, a 1969 underground nuclear explosion in Colorado for studying natural gas production stimulation, are summarized. This summary was extracted from referenced reports on re-entry operations, on-site radiation monitoring, chemical and radiochemical analyses of chimney gas samples, well testing results and evaluation, public health and safety evaluations, and hydrologic evaluations. A section is included on litigation involving the Rulison Event, the documentation of post-shot activities required by the court as the results of three lawsuits, and the court decision to permit re-entry and testing of the Rulison well. (L.C.L.)

38390 (PNE-RB-19) SITE CLIMATOLOGY AND METEOROLOGY. PROJECT RIO BLANCO. (EG and G, Inc., Albuquerque, N. Mex.). 2 Aug 1971. 87p. (AL-603). Dep. NTIS.

For CER Geonuclear Corp., Las Vegas, Nev.

In order to prepare for the remote contingency of inadvertent release of radioactivity from the Rio Blanco Event in northwest Colorado, a study was undertaken to: provide and interpret climatological data required by the various participants for pre-event planning and preparation; and develop predictions of trajectories and dispersion of effluents for selected modes of inadvertent release and selected meteorological conditions, as well as for planned release in production testing. In developing the local climatology of the area, the upper airflow was considered first, then the topography examined and the interactions between the upper airflow and the topographical effects explored, taking into account the local wind statistics. Typical dispersion predictions are considered. (L.C.L.)

38391 (SC-RR-720173) MODELS FOR ELECTROMAGNETIC PULSE PRODUCTION FROM UNDERGROUND NUCLEAR EXPLO-

SIONS. PART IV. MODELS FOR TWO NEVADA SOILS. Vittitoe, Charles N. (Sandia Labs., Albuquerque, N. Mex.). May 1972. 41p. Dep. NTIS.

The frequency variation of the electrical parameters of a sample of Nevada tuff is modeled by a Debye relaxation model. Less success occurs for similar modeling of a dry granite sample. Data from R. L. Ewing are used to estimate the secondary electron mean lifetime in the dry granite sample as 2×10^{-10} s with a mobility of 111 esu. Difficulties with similar estimates for tuff are mentioned, together with resulting uncertainty in calculated electromagnetic fields close to an underground nuclear explosion. Appendices show that the model obeys the Kramers-Kronig relation and contain discussions of an interpretation of large dielectric constants. (auth)

38392 EXPLOSIVE EXCAVATION RESEARCH: PROJECTS TUGBOAT AND TRINIDAD. LaFrenz, Robert L.; Day, Walter C. (Army Engineer Explosive Excavation Research Office, Livermore, Calif.). Nucl. Technol.; 15: No. 3, 75-84(Jul 1972).

Large chemical explosive charges are being used in multiple charge designs in a variety of media and topographic situations to achieve actual construction projects. This program is being conducted with the realization that solving the engineering problems associated with using large point charges to achieve project objectives is a first major step toward the eventual acceptance of the use of nuclear explosives as these point charges. The target is the development of chemical and nuclear explosive excavation as accepted cost competitive construction techniques. Projects conducted in this new approach are TUGBOAT, a small boat harbor in a coral medium at Kawaihae, Hawaii, and most recently TRINIDAD, a series of tests and railroad cuts in a sandstone and shale medium at Trinidad, Colorado. A cost analysis of these latest projects when combined with earlier experience shows a unit cost reduction trend for chemical explosive excavation compared to a unit cost increasing trend for excavation by conventional means. (auth)

38393 CHIMNEY GAS RADIOCHEMISTRY IN NUCLEAR GAS STIMULATION APPLICATIONS. Smith, C. F. (Univ. of California, Livermore). Nucl. Technol.; 15: No. 3, 85-92 (Jul 1972).

Results of the gas quality analysis program for Project Rulison were compared with previous experience. In general, the Rulison results complement those reported for Project Gasbuggy. Anomalous behavior of CO_2 and H_2 was seen in both experiments and is assumed to be due to ebullition of these gases from chimney water. Also, a CO_2 source free of ^{14}C and ^{85}Kr was identified in the Rulison experiment, suggesting late-time liberation of this gas from carbonate minerals. Dilution effects, resulting from gas production plus formation gas influx, appear to control the concentrations of other chimney gas components. Water leakage into the Gasbuggy chimney strongly affected the chemical distribution of tritium in that experiment. No such dilution is suspected at Rulison, and the tritium exchange between hydrogen gas and water appears to have maintained equilibrium throughout the production testing period. Tritium apparently was not exchanged between the hydrocarbon gases and hydrogen or water in either nuclear chimney except at very early times, although an unexplained decrease in the $CH_3T/^{85}Kr$ ratio was observed during production testing of Project Gasbuggy. (auth)

Protective Structures and Equipment

38394 (UCRL-73820) RESPIRATOR CARTRIDGE EFFICIENCY STUDIES. IV. EFFECTS OF STEADY-STATE AND PULSATING FLOW. Nelson, Gary O.; Harder, Charles A. (California Univ., Livermore. Lawrence Livermore Lab.). 22 Mar 1972. 22p. (CONF-720532-1). Dep. NTIS.

From thirty-third annual meeting of the American Industrial Hygiene Association; San Francisco, CA. (15 May 1972).

The service life of organic-vapor respirator cartridges has been evaluated for steady-state and pulsating flow rates; a mechanical breathing simulator was used to evaluate the pulsating flow rates. Two types of cartridges have been tested at work rates of 0, 208, 415, 622, 830, and 1107 kg-m/min and their equivalent respective steady-state flow rates of 14.0, 20.6, 29.8, 36.9, 53.3, and 71.4 liters/min. Cartridge breakthrough characteristics were recorded with both types of flow for several solvents at 1000 ppM and 0, 50, and 80% relative humidity. No significant differences were observed between the steady-state and pulsating flows, even at the highest work rate and humidity conditions. The effective service life appears to be inversely proportional to the flow rate at a given concentration. (auth)

38395 JUNCTION DEVICE. Baudoin, J. C.; Drieu, Fernand (to Commissariat a l'Energie Atomique). French Patent 2,082,650. 15 Nov 1971. Filed 23 Mar 1970. (In French).

A fluid tight junction device which simultaneously connects several channels is described. Each of the channels is provided with a fixed ferrule and a moving ferrule; the moving ferrule can be positioned along the axis of the fixed ferrule in such a way as to facilitate the operation of a common locking mechanism for all the channels. This device is particularly intended to provide a simple apparatus, which is robust and easy to handle (possibly remotely) for ensuring the interconnection, with a given tightness, of a large number of channels bringing or evacuating corrosive and/or dangerous fluids to or from an enclosure or reaction tank. Under these conditions the apparatus should satisfy the requirements of laboratories or the nuclear industry. (France)

38396 REMOTE-OBSERVATION APPARATUS. Chauffier, Jean; Poizat, Emile; Roussel, Emile (to Commissariat a l'-Energie Atomique). British Patent 1,270,030. 12 Apr 1972. Priority date 10 Jul 1968, France.

A remote observation apparatus is described by which magnification can be selected in a wide range without altering the optical components. The control of focal length variation related to the objective and the adjustment of the position of the first adjustable group of lens elements can be effected remotely. In a preferred embodiment, the apparatus is installed in a tube passing through a wall, the tube being sealed by a glass observation window. (J.R.D.)

38397 GASTIGHT SEAL FOR TWO VESSELS. Schrader, Heinrich Rudolf (to Gesellschaft fuer Kernforschung mbH). British Patent 1,270,069. 12 Apr 1972. Priority date 4 Oct 1969, Germany.

A gastight seal for two vessels adapted to receive radioactive or toxic substances is described. One vessel is provided with an inwardly projecting collar and a closure cover, the second vessel is also provided with a closure cover. The second closure cover comprises an upper and a lower cover portion, the upper and lower cover portions are axially displaceable relative to one another and together defining a conical groove of variable cross-section along their outer circumference. An endless spring element is located in the groove and in a corresponding groove provided in the second vessel. The first vessel closure cover and the second vessel are pressed against opposite sides of the collar by the interpositioning of packings, the second vessel closure cover is clamped against one of the packings. (J.R.D.)

38398 USE OF ^{32}P FOR THE FOLLOW-UP OF DROPLET ENTRAINMENT IN GAS CLEANING DEVICES. Doksansky, V. (Statni Vyzkumny Ustav Ochrany Materialu, Prague); Hanzalek, J. Radioisotopy; 13: No. 1, 153-76(1972). (In Czech).

A perforated plate column with foam regime is a part of most devices for industrial exhausts cleaning. The cleaned gas must pass a liquid layer, where the greater part of the entrained solid particles is trapped. The advantages of these columns are the simple construction and the intensification of the gas cleaning process due to the high flow velocity. The high flow velocity, however, causes an entrainment of liquid, which often becomes the limiting factor of the column function. These aspects of gas cleaning are discussed briefly to substantiate the advantages of the radiotracer method. The results are presented in a summarized form. A substantial part of the paper is concerned with the description of radiotracer applications, i.e., the choice of a suitable radionuclide and its activity, measurement methods, calibration, and evaluation of results and their interpretation. (auth)

Safety Engineering

Refer also to abstract 38586.

Vacuum Engineering

38399 ELLIPSOMETRIC MEASUREMENT OF CONTAMINATION IN AN OIL-PUMPED UHV SYSTEM. Rollason, R. M.; Fane, R. W.; Neal, W. E. J. (Univ. of Aston, Birmingham, Eng.). J. Vac. Sci. Technol.; 9: No. 2, 1019-23(Mar-Apr 1972).

Determinations have been made of oil contamination on a surface in an oil pumped ultrahigh vacuum (uhv) system for DC702 and DC705 oil, for different trapping conditions. Contamination layers were detected with an ellipsometer employing a photomultiplier detector. Results show that for DC702 oil and one trap at room temperature, backstreaming resulted in a steady build up of oil contamination of 150 Å h^{-1}. The inclusion of a second trap at room temperature reduced the contamination rate to 25 Å h^{-1}. In the case of DC705 oil, the oil film growth rate with inclusion of one trap at room temperature was 0.05 Å h^{-1}. For a one trap system with the trap at 77°K the backstreaming rate was below detection for either fluid, i.e., well below an average coverage of 5 Å. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

38400 (CEA-CONF-1979) DEVELOPMENT AND PROSPECTS FOR GEOCHEMICAL PROSPECTING OF URANIFEROUS STRATA. Grimbert, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 3p. (In French). (CONF-710456-1). Dep. NTIS (U. S. Sales Only).

From third international symposium on geochemical prospection; Toronto, Canada (Apr 1971).

French studies in the area of geochemical prospecting of uranium deposits are reviewed. The different geochemical prospecting techniques both in the strategic and the tactical region are discussed. These techniques are applied to the analysis of waters and the alluvium of rocks and soils. The studies made on the content of U, Rn, Ra, RaC and ^{234}Th in these media are mentioned. The problems relating to the dispersion of these elements are considered. Numerous subjects of research in order to promote the knowledge and possibilities of geochemical prospecting are suggested. (tr-auth)

38401 EVOLUTIONARY MODEL FOR LEAD ISOTOPES IN CONFORMABLE ORES AND IN OCEAN VOLCANICS. Russell, R. D. (Univ. of British Columbia, Vancouver). Rev. Geophys. Space Phys.; 10: No. 2, 529-49(May 1972).

Recently, absolute isotopic ratios have been published for lead standards. This makes possible for the first time a meaningful comparison of published isotopic ratios of lead from conformable ores with those from oceanic rocks. These classes of material exhibit isotopic patterns that may be of worldwide significance. A preliminary study has been made of the adjusted ratios of 18 conformable ores and 22 oceanic volcanic-rock leads. Each group shows a recognizable pattern such that leads from one regime cannot be obtained by any simple mixture of leads from the other. One widely recognized difference between the patterns is the considerable variation of isotopic ratios for oceanic volcanic samples of similar age, indicative of a heterogeneous source. This contrasts sharply with conformable ores for which isotopic ratios are similar for samples of the same age. Another characteristic, considered to be of equal importance, is the significant deficiency of ^{207}Pb in the oceanic volcanic leads. It is shown that both characteristics can be reproduced by a model in which uranium, thorium, and lead are transferred between two reservoirs. The transport of uranium and thorium must occur more quickly than for lead, and for all elements transport must be sufficiently rapid to reach quasi-steady state in a time much shorter than the age of the earth. The close relationship between this model and bidirectional transport between the systems is discussed. Two forms of the model are presented. In each, the time-varying concentrations of ^{204}Pb approach asymptotic values exponentially with time. Model A, in which the transport of uranium and thorium is very rapid, provides the most recent beginning of differentiation, at a time 2500 Myr ago. Model B, in which the transport of uranium and thorium is also exponentially related to time, corresponds to a differentiation beginning 3000 Myr ago. These seem to be extreme times for the form of the model used. It is suggested that lead-isotope measurements might be used to identify characteristically oceanic materials now in continental areas as the result of tectonic plate movement. (53 references) (auth)

38402 URANIUM EXPLORATION IN ITALY: RESULTS ACHIEVED AND PROSPECTS. Mittempergher, Mario. Com. Naz. Energ. Nucl., Notiz.; 18: No. 4, 25-39(Apr 1972). (In Italian).

The uranium exploration activities conducted in Italy from the early fifties to the present, as well as the prospects of such activities for the coming years, are reviewed. (auth)

38403 NUCLEAR ENERGY IN THE AFRICAN COUNTRIES. Casa, A. F.; Perilli, M. L.; Sansone, M. M. Com. Naz. Energ. Nucl., Notiz.; 18: No. 4, 41-58(Apr 1972). (In Italian).

The status of nuclear energy in the African countries is reviewed. At present only the UAR and South Africa have sizeable national nuclear programs, and a few more countries possess research centers and operating research reactors. A very different picture is that of uranium supplies, since deposits of this mineral have been worked since the early years of the atomic age. (auth)

38404 RADIOMETRIC EVIDENCE FOR THE RAPID GROWTH RATE OF SHALLOW-WATER, CONTINENTAL MARGIN MANGANESE NODULES. Ku, T. L. (Univ. of Southern California, Los Angeles); Glasby, G. P. Geochim. Cosmochim. Acta; 36: No. 6, 699-703(Jun 1972).

Radio-element concentrations in two shallow-water, continental margin ferromanganese nodules from the Jervis Inlet, British Columbia, and Loch Fyne, Scotland, were found to be markedly different from those found in deep sea manganese nodules. Compared with their deep sea counterparts, the shallow-water concretions showed: (1) higher uranium (10 to 20 ppM) and much lower thorium (2 to 5 ppM) contents; (2) very low ^{230}Th and ^{231}Pa activities, such that these nuclides are depleted, rather than enriched, with respect to the amounts which are supported by the uranium present; and (3) two or more orders of magnitude higher growth rate. The higher growth rates, together with the data on Mn/Fe ratios and trace element contents, conform with, though do not prove, the concept of an interstitial source of manganese for nodule accretion in shallow marine environments. (auth)

38405 THORIUM DISTRIBUTION IN A GRANITE STOCK NEAR BULL CANYON, LEMHI COUNTY, IDAHO. Staatz, Mortimer H.; Bunker, Carl M.; Bush, Charles A. (Geological Survey, Denver). U. S., Geol. Surv., Prof. Pap.; No. 800-B, 51-6(1972).

A granite stock underlying an area of about 4.3 square miles occurs on the west side of the Beaverhead Mountains near Bull Canyon, Idaho. This granite body, which is of probable Silurian age, has intruded both the upper Precambrian Belt Supergroup and the Ordovician Kinnikinic Quartzite. The granite consists principally of perthite and quartz with minor amounts of plagioclase, magnetite, biotite, zircon, apatite, rutile, monazite, and allanite. The average thorium content of 16 representative samples from various parts of the stock is 35 ppM. A radiometric map of the granite stock indicates that the most radioactive area occurs along an arcuate ridge near the east edge of the stock. The most radioactive parts of this area are in widely scattered zones along fractures and in small irregular areas. In these abnormally radioactive areas, which may contain in excess of 100 ppM Th, the principal thorium mineral is thorite, which occurs as tiny crystals along fractures. Late-stage post-magmatic fluids are believed to have altered the original granite and deposited the thorite along favorable zones. (auth)

Radioactive Effluents

Refer also to abstracts 38335, 40296, 40313, 40327, 40330, 40339, 40343, 40354, 40367, and 40380.

38406 (CONF-720522-5) ENVIRONMENTAL PROTECTION DURING FUEL PROCESSING. Yarbro, O. O.; Nichols, J. P.; Unger, W. E. (Oak Ridge National Lab., Tenn.). 1972. 11p. Dep. NTIS.

From seventy-second national meeting of the American Institute of Chemical Engineers; St. Louis, MO. (21 May 1972).

The trend toward tightened restrictions on the radioactivity of effluents from nuclear facilities is evident. Recent revisions to 10 CFR, part 50, of the Federal Register reduced the permissible discharge limits from reactors, by approximately a factor of 100 and part 20 was revised to require discharges to be reduced "as far below the limits specified in this part as practicable." In response to these requirements for improved effluent control, methods for removing the volatile fission products are under development. Efficient methods for controlling tritium, krypton-xenon, and iodine in fuel reprocessing plants were demonstrated on a laboratory and small engineering scale. Full-scale demonstrations have not been carried out as yet and many scale-up questions as well as the engineering problems associated with an actual plant application are yet to be answered. An off-gas flowsheet for volatile fission product control is included. (M.C.G.)

38407 (DOCKET-408102-6) HIGHLAND URANIUM MILL. Draft Detailed Statement on Environmental Considerations, etc., Comments and Questions. (Humble Oil and Refining Co., Houston, Tex. Minerals Dept.). 12 Jun 1972. 2p. Dep. NTIS.

38408 (LA-tr-72-17) ANALYSIS OF THE PROBLEMS OF PROTECTION POSED BY FLUORINE AND FLUORINATED COMPOUNDS. Bittel, R.; Vaubert, B. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Los Alamos Scientific Lab., N. Mex., from report CEA-Bib-200. 54p. Dep. NTIS.

Possible origins of a release of fluorine to the environment, especially from uses of fluorine in the nuclear industry, are listed. Damage resulting from intoxication by fluorine and its compounds is defined. Parameters affecting the behavior and the transfer of fluorine in the environment and data concerning admissible levels of fluorine and its compounds are summarized. (81 references) (M.C.G.)

Radioactivity Transport and Monitoring

38409 (EUR-4767) RESULTS OF ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS IN THE COMMUNITY COUNTRIES IN 1970: AIR-FALLOUT-WATER. (European Communities, Luxembourg. Commission). 1972. 76p. (In several languages). Dep. NTIS (U. S. Sales Only). EUR FB 100,-.

Results are given of measurements carried out in 1970 by the member States at the environmental radioactivity monitoring stations, together with certain data obtained at Euratom's Joint Research Center, Ispra. Measurements of radioactivity in the air at ground level, in fallout, and in water are included. Most of these measurements relate to total beta radioactivity. The measurement results for certain specific radionuclides are also given as well as the amount of precipitation observed at fallout sampling stations. Graphs are given to show the pattern followed throughout the year, a comparison being drawn with the development over the years 1962, 1963, 1964, 1965, 1966, 1967, 1968, and 1969 as well as with the situation in 1970 in the United States and Canada. (auth)

38410 SOME HYGIENIC OBSERVATIONS ON RADON. Halik, J. (Vojensky Ustav Hygieny, Epidemiologie a Mikrobiologie, Prague). Fysiat. Reumatol. Vestn.; 49: No. 3, 115-20(1971). (In Czech).

Observations on the operation of balnear stations using radon baths are presented. Climatization of radon procedures should be subject to increased attention so that no active air penetrates to waiting rooms and other premises in balnear establishments. Conventional measuring of radon air concentration is not sufficient for the characteristics of atmospheric condition; radon disintegration products should also be screened. The potential alpha energy screening should be obligatory to such places. Results of the screening of different balnear premises are reported. (auth)

38411 NATURAL RADIATION IN THE URBAN ENVIRONMENT. Yeates, D. B.; Goldin, A. S.; Moeller, D. W. (Harvard School of Public Health, Boston). Nucl. Safety; 13: No. 4, 275-86(Jul-Aug 1972).

Natural radiation is the largest source of population dose and is important as a base line with which radiation-protection standards may be compared. Previous work on natural background radiation levels is summarized, and some new data from Boston, Mass., are reported. Gamma dose rates, corrected for cosmic radiation, were measured with large ionization chambers: dose rates inside wooden single-family dwellings were 25 to 50% lower than those outside; in masonry multiple-family dwellings, they were about 10% lower. Concentrations of radon daughters in the air were measured by predecay and postdecay alpha spectrometry: concentrations in dwellings were comparable with outdoor concentrations, but concentrations in basements were higher by a factor of about 5. Concentrations in office buildings were quite low, the radon daughters being removed by the ventilation system. Effects of building type, construction materials, and ventilation on human dose are discussed, as are possible ways of reducing population dose. (auth)

Atmosphere

Refer also to abstract 38730.

38412 (HASL-256) MEASUREMENT OF RADON DAUGHTERS IN AIR BY ALPHA COUNTING OF AIR FILTERS. Thomas, Jess W. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr 1972. 44p. Dep. NTIS.

A simple method for determination of RaA, RaB and RaC has been developed which has a sensitivity of the order of 1 pCi/l for each nuclide. An air sample is obtained and the total alpha disintegrations in three selected time intervals after the end of air sampling determined. The concentration of each nuclide is then obtained from an equation involving the alpha disintegrations, the sampling flow rate, and known numerical coefficients. Simple equations giving the standard deviation of the nuclide concentrations have also been derived. The method was optimized for accuracy by investigating a large number of sampling times and counting intervals, and it is recommended that 5 minute air sampling be used, followed by alpha counts from 2 to 5, 6 to 20, and 21 to 30 minutes after the end of sampling. (auth)

38413 (IA-1205) RADIOACTIVITY IN THE ENVIRONMENT IN ISRAEL, JULY 1966-JUNE 1968. Feige, Y.; Proulov, I.; Karp, D.; Eisenberg, A.; Shalmon, E.; Asculai, E.; Gaaton, M. (Israel Atomic Energy Commission, Tel Aviv). Feb 1972. 16p. Dep. NTIS (U. S. Sales Only).

The surface air and deposited radioactivity data measured at 4 environmental monitoring stations representative of the various geographical areas of Israel are summarized for the two year period from July 1966 to June 1968. Samples were analyzed by gamma spectroscopy. ^{137}Cs and ^{90}Sr were determined by beta counting after chemical separation. The ^{131}I content of sheep and goat thyroid glands was also determined following atmospheric nuclear tests. (auth)

38414 (PTB-Ra-2/71) PLUTONIUM CONTENT OF THE ATMOSPHERE IN BRAUNSCHWEIG. Wehner, G. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Dec 1971. 21p. (In German). Dep. NTIS (U. S. Sales Only).

Since the middle of 1969, ^{239}Pu and ^{240}Pu contents have been measured together at the physical-technical institute in Braunschweig. Samples were taken at 1.5m above ground level. The method of sampling, treatment of filters, chemical separation of plutonium, and plutonium determination by α-counting are reported. Results showed that the ^{239}Pu concentrations were 0.6% of the maximum permissible concentration (MPC) for general populations which were assumed to be $\frac{1}{30}$ of the MPC for professionally exposed personnel. For ^{90}Sr, the corresponding value was 0.2%. For γ-emitting radionuclides, the corresponding values were even lower. (H.B.G.)

38415 SCREENING EFFECT OF CONTINENTS WHICH DETERMINES THE ISOTOPIC COMPOSITION OF ATMOSPHERIC MOISTURE (BASED ON THE TRITIUM SPACE-TIME DISTRIBUTION IN THE ATMOSPHERIC PRECIPITATION OF THE NORTHERN HEMISPHERE). Soifer, V. N.; Romanov, V. V.; Gasilina, N. K.; Roslyi, E. I. (Inst. of Water Problems, Moscow). Dokl. Akad. Nauk SSSR; 201: No. 1, 78-81(1 Nov 1971). (In Russian).

The average yearly fallout of tritium in the northern hemisphere was estimated from measurements in June, August, September, and November in a number of Russian cities. For geophysical interpretation of the results of tritium in sedimentation, the average concentration of tritium in a 5-kilometer column of atmospheric moisture was taken to be equal to the tritium concentration in the average monthly precipitation from it. The data are discussed in terms of a "screening" effect of the continental surface, in contrast to tritium in the atmospheric moisture above the oceans. This effect led to an enrichment of tritium in the atmospheric moisture of stratospheric origin in proportion to its advance into the interior of a continent. Conversely, the moisture above the ocean is subject to intense "washing-out" because of evaporation and molecular exchange at the surface of well-mixed water layers. (K.S.W.)

38416 ESTIMATE OF THE WORLD BUDGET OF FALLOUT SILVER NUCLIDES. Hodge, V. F.; Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif.). Nature (London); 237: No. 5350, 98-9(12 May 1972).

An estimate was made of the ^{110m}Ag budget from the ratios of reported concentrations of fallout ^{90}Sr and ^{110m}Ag collected at high altitudes over the northern hemisphere from July to Dec. 1963. Results are in good agreement with assessments made from determinations in fish livers. A study is also being made to determine the world budget of ^{108m}Ag. (UK)

Water

Refer also to abstract 38129.

Ecosystems and Food Cycles

Refer also to abstracts 38758 and 38803.

38417 ECOLOGICAL STUDIES OF A FRESH-WATER ENVIRONMENT. Cigna Rossi, L. (CNEN-CSN, Casaccia, Italy). Minerva Fisiconucl.; 15: No. 3, 131-4(Jul-Sep 1971). (In Italian).

The first stage of a series of studies to be conducted on the ecology of a small stream (Fossetto) near the Casaccia Nuclear Center is described. Particular reference is made to the first findings obtained concerning the flora and an example of the phytosociological surveys is presented. Details of the research program and its proposed physical, chemical, physicochemical, and biological determinations are given. Radioactive tracers may be employed, if required, to investigate the fate and distribution of certain radionuclides in the stream. (auth)

38418 TRITIUM IN PINE TREES FROM SELECTED LOCATIONS IN THE UNITED STATES, INCLUDING AREAS NEAR NUCLEAR FACILITIES. Stewart, G. L. (Univ. of Massachusetts, Amherst); Wyerman, T. A.; Sherman, Max; Schneider, Robert. U. S., Geol. Surv., Prof. Pap.; No. 800-B, 265-71(1972).

Pine needles were sampled at several selected locations in the conterminous United States to determine if the natural tritium rainout pattern can be correlated with tritium in free water and in bound hydroxyls of new and old growth. Near nuclear facilities which are known to release tritium to the environment, the objective was to obtain some information on the distribution pattern and fate of tritium in nearby vegetation. Excluding samples near the nuclear facilities, the tritium concentrations in pine needles followed a geographic pattern similar to that for the rainout of bomb-produced tritium—a general increase with latitude and distance from the ocean. However, tritium concentrations were greater in plant tissue than would be expected from natural rainout. At the Savannah River Plant, South Carolina, the data clearly indicate a decreasing concentration of tritium with distance from the release areas. (auth)

38419 ECOLOGICAL ASPECTS OF PLUTONIUM DISSEMINATION IN TERRESTRIAL ENVIRONMENTS. Romney, E. M.; Davis, J. J. (Univ. of California, Los Angeles. Atomic Energy Commission, Las Vegas, Nev.). Health Phys.; 22: No. 6, 551-7 (Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The technology of plutonium production and processing is already established, but the realization of its peaceful applications depends largely upon the development of methods for preventing its distribution in the environment. Because of safeguards and effective control measures, no accidental plutonium contamination of the public domain has imposed serious risks to a population group. Trace amounts of plutonium from above-ground nuclear detonations are contained in world-wide fallout; however, the levels of plutonium in foodstuffs and other components of the environment are insignificant compared to the amounts known to be hazardous. There has thus been very little interest in the study of ecological aspects of plutonium contamination. The result is a paucity of information on the behavior of plutonium in ecosystems and its radiological effects on natural fauna and flora. The Nevada Applied Ecology Group is embarked upon a program at the Nevada Test Site to investigate the long-range effects of plutonium disseminated into the desert ecosystem. Emphasis has been placed upon standardization of analytical methods, delineation of contaminated areas, problems of resuspension and redistribution, food chain transport and ecological effects. (auth)

38420 CRITICAL PARAMETERS IN PLUTONIUM SAFETY EVALUATIONS. Dix, G. P.; Dobry, T. J. (Atomic Energy Commission, Washington, D. C.). Health Phys.; 22: No. 6, 569-74(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The critical parameters in performing safety analyses of systems utilizing plutonium are discussed from the viewpoint of those who must apply environmental and biomedical research information to solve engineering problems. It has been observed that the physical and chemical state of Pu (source term) will be modified significantly from the time of its release until the time of human contact. Some examples of source term modifiers in aquatic and terrestrial environments are given. (auth)

38421 TECHNOLOGY FOR THE PRODUCTION OF MONODISPERSE AEROSOLS OF OXIDES OF TRANSURANIC ELEMENTS FOR INHALATION EXPERIMENTS. Kotrappa, P.; Wilkinson, C. J.; Boyd, H. A. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 22: No. 6, 837-43(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

A method of preparing and aerosolizing monodisperse particles of oxides of transuranic elements is discussed. A four-step process, involving source aerosol preparation, centrifugal separation, resuspension and aerosolization was applied to plutonium dioxide. The procedure consists of generating an aerosol by nebulizing a solution of a transuranic element such as plutonium chloride, degrading the particles that are formed with a high temperature heating column to form a polydisperse aerosol of the oxide, separating and collecting this polydisperse aerosol in monodisperse aerodynamic size groups on a stainless steel collection foil in the Lovelace Aerosol Particle Separator (LAPS) and resuspending the monodisperse particles in water for future aerosolization by nebulization. The LAPS is a centrifugal device, that provides a continuous separation of aerosol particles down to an aerodynamic diameter of 0.5 μm. Air activity and particle size data obtained during an actual exposure of Beagle dogs to monodisperse aerosols of PuO_2 obtained by this method are presented. The method was used to provide monodisperse aerosols of plutonium oxide, over a wide range, with controlled and reproducible physico-chemical characteristics. Adaptation of the procedure for other transuranic oxides is discussed. (auth)

38422 ^{90}Sr CONTENTS OF HUMAN BONES IN FINLAND, 1963 TO 1966. Salo, Kalervo; Uotila, Unto. Ann. Acad. Sci. Fenn., Ser. A V; No. 141, 1-24(1969).

The project of determining the ^{90}Sr content of human bone has been continued. The chief reason for this has been the desire to obtain data for determining the discrimination factors involved in the biocyclic transfer of ^{90}Sr from the diet to the human body. In part, the reason for continuing the study has been the northerly situation of Finland, north of latitude 60°N, and the fact that the population of the country obtains about 85% of its calcium requirement from milk (Roine 1954). (auth)

Radiometric Techniques

Refer also to abstracts 38128, 38362, and 38404

38423 (COO-3566-3) DISTRIBUTION OF SOME CHEMICAL ELEMENTS BETWEEN DISSOLVED AND PARTICULATE PHASES IN THE OCEAN. Period Covered: August 1, 1969–July 31, 1972. (Woods Hole Oceanographic Institution, Mass.). 1972. Contract AT(11-1)-3556. 153p. Dep. NTIS.

Developments are reported for studies on the deep nepheloid layer in the N. W. Atlantic Ocean, chemistry of Cariaco Trench, and trace element profiles from the GEOSECS test station in the Sargasso Sea. Two sections on trace metal analysis of seawater by gas chromatography of metal chelates and the surface chemistry of hydrous manganese dioxide were not in scope for NSA. (P.C.H.)

38424 (NVO-1229-176) EVALUATION AND SELECTION OF TRACERS FOR FIELD MEASUREMENT OF COEFFICIENT OF DISPERSION. Essington, E. H. (Teledyne Isotopes, Las Vegas, Nev.). Oct 1971. Contract AT(29-2)-1229. 43p. Dep. NTIS.

A field study was designed to determine the degree of dispersion in a saturated desert alluvium aquifer. In support of the field studies, laboratory studies were conducted to test and select a group of tracers with properties consistent with conditions and restrictions required for the field site. Tracers meeting the basic properties required for the study were subjected to batch sorption studies, and to column leaching studies to measure their potential applicability in the materials native to the study site. As a result of this testing, three tracers, I^-, HTO and ^{60}Co-CDTA were chosen for use in the field study. (auth)

38425 NEUTRON METHOD FOR MEASURING THE WATER CONTENT OF STONY SOILS. Couchat, P.; Ramodiharilafy, J. (CEN, St. Paul lez Durance, France). Int. J. Appl. Radiat. Isotop.; 23: No. 5, 229-35(May 1972). (In French).

The influence of stones on the neutron moisture meter response was studied. A comparison between the experimental and calculated values allows three kinds of influence to be defined: the volume stone percentage is the important parameter; a displacement of the calibration curve which corresponds with a variation of 5 points to 20 volume points is obtained when this parameter varies from 0 to 50 percent. The granulometry does not influence the calibration curve, but the spatial stone distribution plays an important role. This effect leads to a proposal to replace the retrodiffusion method by the transmission method using fast neutrons. (auth)

38426 Rb–Sr AND FISSION-TRACK AGE DETERMINATIONS IN THE PRECAMBRIAN PLUTONIC BASEMENT AROUND THE SUPERSTITION VOLCANIC FIELD, ARIZONA. Stuckless, J. S.; Naeser, C. W. (Northern Illinois Univ., Dekalb). U. S. Geol. Sur., Prof. Pap.; No. 800-B, 191-4(1972).

The plutonic rocks of the Precambrian basement around the Superstition volcanic field, Arizona, show the effects of three geologic events. The oldest is the emplacement of quartz diorite, and the second is the emplacement of granite (1,395 ± 45 My by Rb–Sr mineral and whole-rock isochron and 1,390 ± 40 My by fission-track age in sphene). The second event was intense enough to completely reset the fission-track age for sphene in the quartz diorite (1,390 ± 60 My) and to disturb the Rb–Sr whole-rock isochron (1,540 ± 84 My). The third event is related to cooling of the rock below 100°C after Laramide uplift and is indicated by a fission-track age in apatite of 50.1 ± 0.8 My. (auth)

Site Surveys

Refer also to abstracts 38335 and 40378.

38427 (USGS-474-144) HYDRAULIC TESTING OF HOLE UA-1-HTH-1, AMCHITKA ISLAND, ALASKA. Amchitka-32. Ballance, Wilbur C.; Dinwiddie, G. A. (Geological Survey, Denver, Colo.). May 1972. Contract AT(29-2)-474. 27p. Dep. NTIS.

Hole UA-1-HTH-1 was drilled and hydraulically tested in July and August 1971. The elevation of land surface at the site is 50.13 meters (164.48 feet) above mean sea level. Total depth of the hole was 1,054 meters (3,458 feet) but, because of borehole erosion and bridging, only about 198 meters (650 feet) of the hole was hydraulically tested with straddle packers. Some information was obtained on the lower part of the hole by use of the pressure recorders which are used with the straddle packers. The heads below land surface in that part of the hole tested with straddle packers ranged from 3.9 meters (12.7 feet) in the interval 80.5 to 125.0 meters (264 to 410 feet), the uppermost zone tested with straddle packers, to 5.7 meters (18.6 feet) in the interval 227.4 to 278.6 meters (746 to 914 feet), the lowermost part of the hole tested with straddle packers. The composite static water level obtained following a pumping test was 5.5 meters (18.0 feet). The composite head below 278.6 meters (914 feet), determined from a pressure recorder, was about 12.2 meters (40 feet). The head distribution indicates a decreasing head with depth. Water samples were collected from two intervals for chemical, radiochemical, and ^{14}C analysis. The unadjusted age of water in the interval 183.5 to 234.7 meters (602 to 770 feet) was determined to be 8,410 years, and for the interval 227.4 to 278.6 meters (746 to 914 feet) was 17,880 years. After adjustment the ages of the waters may be less; however, they would still be in the thousands of years and the relative difference probably would still be real. (auth)

38428 SPECTRAL TREATMENT OF ACTIONS OF THREE EARTHQUAKE COMPONENTS ON STRUCTURES. Chu, S. L. (Sargent and Lundy Engineers, Chicago); Amin, M.; Singh, S. Nucl. Eng. Des.; 21: No. 1, 126-36(1972).

A discussion is given of a procedure for applying response spectrum techniques to estimate the simultaneous actions of three earthquake components on the same response in an arbitrary elastic structure. The procedure is applied to the analysis of a nuclear-reactor facility and the results are checked with those obtained from a complete time-history analysis of the system. (auth)

38429 AEC AUTHORIZING LEGISLATION FISCAL YEAR 1973. PART 5: VOLUME 1. ENVIRONMENTAL STATEMENTS 1 THROUGH 8. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, SECOND SESSION, JANUARY 26; FEBRUARY 3, 17, 22, 23, 29; MARCH 1, 8, AND 9, 1972. Washington, D. C.; Joint Committee on Atomic Energy (1972). 1147p. (WASH-1521). GPO $4.50.

This part of the printed record of the Atomic Energy Commission authorization hearings for fiscal year 1973 contains environmental statements on each of several projects which are included in the USAEC authorization request for fiscal year 1973. These projects are: Radioactive Waste Evaporator and Auxiliaries, Richland, Wash.; Contaminated Soil Removal Facility, Richland, Wash.; Rover Fuels Processing Facility, NRTS, Idaho; Land Acquisition, Rocky Flats Plant, Colo.; Plutonium Recovery Facility, Rocky Flats Plant, Colo.; Plutonium Facility, Los Alamos, N. M.; and Liquid Metal Fast Breeder Reactor Plant. (L.C.L.)

38430 AEC AUTHORIZING LEGISLATION FISCAL YEAR 1973. PART 5: VOLUME 2. ENVIRONMENTAL STATEMENTS 9 THROUGH 15. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATE, NINETY-SECOND CONGRESS, SECOND SESSION, JANUARY 26; FEBRUARY 3, 17, 22, 23, 29; MARCH 1, 8, AND 9, 1972. Washington, D. C.; Joint Committee on Atomic Energy (1972). 1006p. (WASH-1516). GPO $4.00.

This part of the printed record of the USAEC authorization hearings for fiscal year 1973 contains environmental statements on each of the following projects which are included in the AEC authorization request for fiscal year 1973: Elk River Reactor Dismantling; Power Burst Facility (NRTS, Idaho); Plutonium-238 Fuel Fabrication Facility (Savannah River, S. C.); National Accelerator Laboratory (Batavia, Ill.); Rio Blanco Gas Stimulation Project; Wagon Wheel Gas Stimulation Project; and Bedrock Waste Storage Evaluation (Savannah River, S. C.). (L.C.L.)

Thermal Effluents

Refer also to abstracts 40299, 40313, 40327, 40339, 40343, 40345, 40351, 40352, 40367, and 40379.

38431 (ANL/ES-11) HEATED-EFFLUENT DISPERSION IN LARGE LAKES: STATE-OF-THE-ART OF ANALYTICAL MODELING. PART 1. CRITIQUE OF MODEL FORMULATIONS. Policastro, A. J.; Tokar, J. V. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-Eng-38. 374p. Dep. NTIS.

This report is part of a three-part literature survey to delineate the state-of-the-art of available methods for predicting heated-effluent dispersion from power-plant condenser-cooling-water discharges into large lakes. This report, which will be periodically updated, concentrates solely on mathematical predictive methods. Two companion reports assess the state-of-the-art of hydraulic modeling (E. Silberman and H. Stefan, Physical (Hydraulic) Modeling of Heat Dispersion in Large Lakes: A Review of the State of the Art, ANL/Es-2, Aug 17, 1970) and delineate existing field data (J. V. Tokar, Thermal Plumes in Lakes: Compilations of Field Experience, ANL/ES-3, Aug 1971) which could possibly be used to validate predictive methods. Essentially 16 mathematical models have been critically reviewed concerning their formational development. Criticisms have been made discussing individual model treatment of geometric, kinematic, hydrodynamic, and thermodynamic variables. The models have been categorized according to their regime of applicability, and contrasting and congruous qualities between models within each category have been summarily presented. (auth)

38432 (HEDL-TME-72-46) TOPLYR-II, A TWO-DIMENSIONAL THERMAL-ENERGY TRANSPORT CODE. Kolesar, D. C.; Sonnichsen, J. C. Jr. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1972. Contract AT(45-1)-2170. 81p. Dep. NTIS.

TOPLYR-II models, in certain types of rivers and lakes, the time varying transport of energy caused by the discharge and subsequent dissipation of condenser cooling water from electric power plants. The model flow field possesses a negligible vertical temperature gradient, and is located where the momentum source due to the plant discharge no longer affects the flow. TOPLYR-II is a modification of the TOPLYR code (HEDL-TME 71-39). As in TOPLYR, the mathematical formulation of the law of conservation of thermal-energy is employed to equate accumulation to convective (via mean current), to diffusive and to source and sink terms. TOPLYR-II differs from TOPLYR primarily in that equations accurate to second-order rather than first-order have been employed to reduce errors due to numerical dispersion. The fluid depth is allowed to vary with position. The heat source is introduced as a temperature boundary condition which is permitted to change with time. An alternating-direction implicit algorithm is employed to solve the finite difference equations once velocity distribution, thermal eddy diffusivities, meteorological conditions, bottom contour, initial fluid temperature distribution and inlet fluid temperature (a function of time) are supplied. TOPLYR-II results compare favorably with field data. (auth)

38433 (HW-66026) MPC's FOR INGESTION OF RARE EARTHS IN COLUMBIA RIVER WATER. McConiga, M. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 1 Sep 1960. Contract AT(45-1)-1350. 7p. Dep. NTIS. Declassified 1 Nov 1971.

Radioactive rare earths and other radionuclides are discharged into the Columbia River in cooling water from the HAPO reactors. Two analyses of the quantities and relative abundances of nuclides of the rare earth and yttrium analytical group in reactor effluent were started in October, 1956. Provisional MPC's for the rare earth group in drinking water derived from the Columbia River were established from the analyses based on individual rare earth MPC's of National Bureau of Standards Handbook 52 and the HAPO Radiation Protection Standards, HW-25457 Rev. 1. A third analysis was begun in April, 1960 to determine if relative abundances of rare earth nuclides in reactor effluent had changed with operational changes. MPC's for the rare earth mixture in drinking water were calculated from isotopic concentrations of the 1960 analysis and MPC's of NBS Handbook 69. Results of the 1960 analysis plus a recalculation from corrected isotopic concentrations of the 1956 analyses indicate that limits in use since 1956 for rare earths in drinking water (GI tract, 3×10^{-4} μCi/cc; bone, 0.5 μCi/cc) are more restrictive than necessary and limits nearer the calculated values are recommended as follows: GI tract, 4×10^{-4} μCi/cc and bone, 0.6 μCi/cc. (auth)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 38539, 38801, 38809, and 40380.

38434 (ANL–7915) BLACK NEUTRON DETECTOR. Poenitz, W. P. (Argonne National Lab., Ill.). Apr 1972. Contract W-31-109-eng-38. 60p. Dep. NTIS.

A detector has been designed for use as a fast-time-response, absolute-neutron-flux monitor in the fast-energy range. A neutron beam enters a scintillator system through an entrance channel. The neutrons lose most of their primary energy in successive collisions within the scintillator. The sum of the light produced by the recoil hydrogen atoms is detected by several photomultipliers. The response and spectra for incident monoenergetic neutrons are investigated with Monte Carlo calculations. The Monte Carlo program, CARLO BLACK, in FORTRAN IV for the SEL 840 MP/EAU computer is given. Proper dimensions for a Black Neutron Detector suitable for use of neutrons up to 10 MeV are derived from these calculations. (auth)

38435 (AREAEE–123) MEASUREMENTS OF THERMAL NEUTRON TEMPERATURE BY THE TECHNIQUE OF BORON FILTERS. Gaafer, M.; Nassar, S. F.; Hamouda, I. (Atomic Energy Establishment, Cairo (Egypt). Reactor and Neutron Physics Dept.). 1971. 16p. Dep. NTIS (U. S. Sales Only).

The effective neutron temperature of the UA-RR-1 vertical dry channel 36/6 was obtained by least squares fitting of the experimental transmission data obtained by the passage of the neutron beam through successive boron filters of different thicknesses to the calculated values. Calculations were based on the assumption that the neutron spectrum consists of a Maxwellian component having a temperature T_n plus a Fermi component. The two components match at a thermal cut off energy E_c. Both T_n and E_c were treated as thermal spectral indices. Neutrons were detected by a boron trifluoride gas proportional counter. A cadmium filter of about 0.6 mm in thickness was used to avoid the influence of fast and epithermal neutrons. The experimental transmission data were corrected for solid angle variation and for neutron attenuation through air in the flight path length. The results indicated that maximum neutron spectrum hardening exists close to the geometrical core center, whereas appreciable softening is characteristic of space points at both ends of the fuel rod near by the reflector. (auth)

38436 (BNWL-SA–4207) COLLIMATED SCANNER ADDITION TO HANFORD SHADOW SHIELD IN-VIVO COUNTER. Andersen, B. V.; Jech, J. J.; Heid, K. R. (Battelle Pacific Northwest Labs., Richland, Wash.). [1972]. 13p. (CONF-720614–1). Dep. NTIS.

From Health physics annual meeting; Las Vegas, NV. (12 Jun 1972).

A modified shadow shield body counting system used to determine relative radionuclide distribution in the body simultaneously with a normal whole body count is described. (W.H.K.)

38437 (CERN-Trans–72-2) IONIZATION CHAMBER WHEN PLACED IN A MAGNETIC FIELD. Kocharov, G. E.; Yamshchikov, M. A. Translated by B. Hodge (CERN, Geneva, Switzerland), from Izv. Akad. Nauk SSSR, Ser. Fiz.; 24: 350-6(1960). 13p. Dep. NTIS (U. S. Sales Only).

The operation of ionization chambers in magnetic fields for studying nuclear reactions and for investigating α-spectra of both long- and short-lived isotopes (including α coincidences with conversion electrons) is studied. Topics include the effect of the magnetic field on electronic equipment, movement of ionization electrons in the presence of the magnetic field, influence of the magnetic field on conversion electrons, and effect of the magnetic field on the δ electrons. (W.H.K.)

38438 (CONF-720607–1) LOW LEVEL NEUTRON FLUX MONITORING SYSTEM FOR LMFBR'S. Ackermann, N. J. Jr.; Roux, D. P.; Clay, W. T.; Guerrant, G. C. (Oak Ridge National Lab., Tenn.). 1 Feb 1972. 4p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

The design and testing of a low level neutron flux monitoring (LLFM) system for use in LMFBR's are described. The LLFM system comprises a ^{235}U fission counter, a high temperature connector and cable assembly, a low-noise preamplifier operated in the current mode, pulse shaping and amplification circuits, a pulse height discriminator, and a 100 MHz scales. (W.H.K.)

38439 (CONF-720607–12) FORMULATION OF THE GAMMA PILE-UP EFFECT IN FISSION COUNTERS. Roux, D. P.; Robinson, J. C. (Oak Ridge National Lab., Tenn.). [nd]. 4p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

The neutron response of fission counters (FC) exposed to very high gamma fluxes is strongly degraded by the pile-up of undesired gamma ray detections. An expression is derived which was experimentally verified to express the amplitude distribution of the gamma pile-up (GPU) as a function of the gamma flux and detector parameters such as the electron collection time. As a result of this study, FC users and designers should be able to accurately predict the GPU effect in their reactor applications. (W.H.K.)

38440 (EUR–4791) RESPONSE FUNCTIONS OF POLYETHYLENE MODERATOR SPHERES FOR NEUTRON ENERGIES IN THE RANGE 5 keV TO 600 keV. Dolias, M. (European Communities, Brussels (Belgium). Commission. Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Mar 1972. 34p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 50,-.

Response functions of various polyethylene spheres used in the multisphere system are determined for monoenergetic neutrons with energies between 5 keV and 600 keV. Neutrons were produced by a 5 MeV Van de Graaff accelerator. Studied sphere diameters varied from 2 to 15", the detector in the centers being lithium-6 iodide crystals or boron trifluoride counters. A shadow bar was used to eliminate air diffusion effects. The Van de Graaff Laboratory was prepared to avoid as far as possible ground and wall diffusion. (auth)

38441 (EUR–4801) VARIABLE DEAD TIME NEUTRON COUNTER FOR TAMPER RESISTANT MEASUREMENTS OF SPONTANEOUS FISSION NEUTRONS. Birkhoff, G.; Bondar, L.; Coppo, N. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 8p. (CONF-710940–4). Dep. NTIS (U. S. Sales Only). EUR B.Fr. 25.-.

From International meeting on nondestructive measurement and identification techniques in nuclear safeguards; Ispra, Italy (20 Sep 1971).

The system consists of a high efficiency moderating neutron detector and five neutron pulse counters with variable dead times of nominal $\tau_0 = 0.03\ \mu s$, $\tau_1 = 16\ \mu s$, $\tau_2 = 32\ \mu s$, $\tau_3 = 64\ \mu s$, $\tau_4 = 128\ \mu s$. The neutron counting rate, C_K, of the counter with dead time τ_K is depending on the multiplicity, ν, of the fission process. From the set of five measurements K = 0, 1, 2, 3, 4 it is possible to verify the spontaneous fission isotope and to determine its amount. The instrument is used for the nondestructive determination of the ^{240}Pu content in plutonium bearing fissile materials. (auth)

38442 (IFA-NR–37) ABSOLUTE MEASUREMENT OF ^{239}Pu ALPHA ACTIVITY BY LOW-GEOMETRY METHOD. Marinescu, L.; Petrascu, M.; Simion, V. (Institutul de Fizica Atomica, Bucharest (Romania)). Jul 1971. 15p. Dep. NTIS (U. S. Sales Only).

The results obtained in the absolute measurements of the alpha activity of some ^{239}Pu sources by the low-geometry method are presented. The alpha particles were detected by a Si(Li) detector. An accuracy of about 0.2 to 0.4% in determination of the activity was obtained. (auth)

38443 (IFA-PN–23) HEAVY ION REGISTRATION IN SOLID TRACK DETECTORS. Haseganu, D. (Institutul de Fizica Atomica, Bucharest (Romania)). Sep 1971. 7p. Dep. NTIS (U. S. Sales Only).

A study is performed for pointing out the role of the primary and secondary ionization in the track formation mechanism in plastic detectors. The thin-down length was measured for ^{12}C, ^{22}Ne, ^{31}P, and ^{40}Ar and it was found to be inversely proportional to ^{2}Z. This dependence is a function of the etching parameters. It is concluded that both of the two ionization orders contribute to track formation, their contributions being pointed out by a suitable choice of the etching conditions. (auth)

38444 (INR–1378) CdTe NUCLEAR RADIATION DETECTORS. Khvashchevska, Yanina; Dombrovski, Andzhei; Lekhovich, Tadeush; Gir'yat, Vitol'd (Institute of Nuclear Research, Warsaw (Poland)). 1972. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The design and fabrication of cadmium telluride radiation detectors are described. Surface barrier technology is applied for preparing the junction. The current–voltage characteristics and the response to monoenergetic alpha particles and gamma radiation were measured. (auth)

38445 (ORNL–TM–3787) MEASUREMENT OF DOSE RATES FROM RADIATION ACTIVATED LIGHT SOURCES. Niemeyer, R. G. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 27p. Dep. NTIS.

Methods for measuring the radiation dose rates from small commercial light sources containing ^{147}Pm and ^{85}Kr are presented along with data illustrating the uncertainties due to geometry, energy dependence, and detector calibration procedures. (9 figures, 8 tables) (auth)

38446 PROCESS FOR FIXING A SEMICONDUCTOR RADIATION DETECTOR CRYSTAL ON A SUPPORT: THE DETECTOR OBTAINED. Meuleman, Johannes (to La Radiotechnique-Compelec). French Patent 2,074,754. 8 Oct 1971. Filed 26 Jan 1970. (In French).

A system for rigidly fixing a semiconductor detector crystal to its support using only a small part of the side faces of the crystal is described. PIN coaxial crystals can, in this way, be fixed to their supports without using the outer side walls if the crystal is provided with a cavity. The dimensions of the support can be varied by altering its temperature. At least part of the support is subjected to a temperature different to that at which the detector is used. The fixation results from expansion or contraction (crystal with cavity). The support is suitable for all detector configurations and is inexpensive due to its easy construction. It is preferably metallic with the fixation part in electrical contact with a region of the crystal. (France)

38447 DEPENDENCE OF THE DEEXCITATION TIME OF THE SLOW COMPONENT IN XENON ON PRESSURE. Lyashenko, V. I.; Semenov, V. G.; Florek, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1328-9(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 60-2(Sep-Oct 1971).

The results of measurements of the deexcitation time τ_m of the slow component in xenon in the pressure range 150 to 760 torr are presented: τ_m (ns) = $(8 \pm 2)10^4$ p^{-1}, where p (torr) is the pressure. The results of the measurements are compared with the results obtained by other authors. (2 figures) (auth)

38448 PLASTIC SCINTILLATORS CONTAINING DEUTERIUM. Gunder, O. A.; Malinovskaya, S. A.; Teslya, L. E. (All-Union Scientific-Research Inst. of Single Crystals, Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1349-50(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 78-9(Sep-Oct 1971).

Plastic scintillators based on the corresponding polymethylmethacrylates are described which contain deuterium. (auth)

38449 MEASUREMENTS OF THE DEPENDENCE OF THE LUMINESCENCE YIELD OF SCINTILLATED CRYSTALS ON THE RADIATION ENERGY. Kulinich, Yu. A.; Rukavishnikov, V. G. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1351-3(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 79-82(Sep-Oct 1971).

A description is given of a network for a two-crystal spectrometer, and the parameters of the instrument are given. The spectrometer operates in a mode in which energy selection of the particles is performed as a function of the scattering angle, and is designed for measurements of the luminescence yield of scintillators. The spectrometer described allows measurements to be carried out both on scintillators having a short deexcitation time (scintillating plastic, stilbene, etc.) and on crystals having a long deexcitation time (CsI, NaI, etc.). In the coincidence mode the amplitude of the measured signals is ≃75 keV for electrons and ≃300 keV for protons when an FÉU-53 photomultiplier is used. The linearity of the unit is at worst 2%. (auth)

38450 EFFICIENCY OF CHARGE COLLECTION IN SEMICONDUCTOR NUCLEAR-RADIATION DETECTORS. Vasil'ev, A. M.; Zakharchuk, O. V.; Fedoseeva, O. P. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 4, 1032-4(Jul-Aug 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 4, 74-6(Jul-Aug 1971).

A theoretical analysis is made of charge collection in semiconductor detectors having a thin entry window when the mean free path of the ionizing particle exceeds the width of the sensing region. Intensive exchange of electrons on the metal-semiconductor boundary is considered. It is shown that the leakage of electrons as a consequence of diffusion to the working contact leads to a noticeable reduction of the efficiency of charge collection. The results obtained explains the experimentally observed reduction of the collection efficiency in semiconductor detectors. (auth)

38451 END-WINDOW MULTIFILAMENT NEUTRON DETECTOR. Vorona, P. N.; Maistrenko, A. N. (Academy of Sciences, Kiev). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1343-5(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 72-5(Sep-Oct 1971).

An end-window multifilament $^{10}BF_3$ detector developed for recording cold neutrons with a time-of-flight spectrometer is described. The input window having an area of ~150 cm^2 is fabricated from aluminum 0.5 mm thick. The nonworking $^{10}BF_3$ layer of the detector end-face is completely absent. The efficiency with which cold neutrons ($E_n \leq 0.005$ eV) are recorded is approximately 100%. The extent of the plateau of the counting characteristic is 400 V with an overall slope <1%. The maximum time delay of a neutron pulse is approximately 1 to 1.5 μsec. (auth)

38452 THIN-LAYER LOW-BACKGROUND SCINTILLATION DETECTOR FOR SOFT PROTONS. Afonin, A. I.; Bondarenko, L. N. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1346-8(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 75-8(Sep-Oct 1971).

Methods are described for obtaining thin (0.1 to 0.3 μ) layers of a scintillator consisting of CsI(Tl), NaI(Tl), and an electronic network based on the selection of pulses according to the steepness of the leading edge, which reduces the background of the scintillation detector. The principal characteristics of the developed soft-proton detector are presented. (auth)

38453 TWO-DIMENSIONAL ANALYZER FOR MEASUREMENT OF LIFETIME BY THE METHOD OF GAMMA–GAMMA COINCIDENCES USING THE MINSK-2 COMPUTER. Morozov, V. A.; Razov, V. I.; Fominykh, V. I.; Tsupko-Sitnikov, V. M. (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1354-7(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 83-6(Sep-Oct 1971).

Based on the "Minsk-2" electronic computer, an installation has been created for two-dimensional measurements of the half-lives of the excited states of nuclei in the nanosecond range. KhR-1020 photomultipliers with NaI(Tl) scintillators (40 × 40 mm^2) were used in the installation. The results of measuring the half-lives of excited states of ^{155}Gd are presented. (auth)

38454 ANTICOINCIDENCE NETWORK FOR THE NANOSECOND RANGE. Avdeev, V. A.; Kuznetsov, V. M. (Tomsk Polytechnic Inst., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1358-9(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 87-8(Sep-Oct 1971).

A high-speed anticoincidence network based on a transistorized current switch is described. For a resolving time of 5 to 10 nsec the limiting loading of the network is 10^8 pulses/sec for 100% efficiency of forbiddenness of a statistically distributed signal. The width of the plateau of the forbiddenness curve may be controlled from 3 nsec up. (auth)

38455 DETERMINATION OF THE COORDINATES OF PARTICLES IN A PROPORTIONAL CHAMBER. Biryukov, V. A.; Zinov, V. G.; Konin, A. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1334-6(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 65-7(Sep-Oct 1971).

It is shown that in multifilament proportional chambers with potentiometric takeoff of information the accuracy with which the coordinates of the spot corresponding to the transient of charged particles for inclined incidence relative to the plane of the filament is considerably higher than it is for perpendicular incidence. (auth)

38456 EFFECT OF AN ELECTRIC FIELD ON THE RECORDING OF IONIZING PARTICLES IN A PHOTOGRAPHIC EMULSION. Kolyubin, A. A.; Kalashnikova, V. I.; Lemeshko, B. D.; Pevchev, Yu. F. (Moscow Engineering-Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1340-2 (Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 69-72(Sep-Oct 1971).

A change in the sensitivity of a photographic emulsion layer due to the influence of both pulsed and high-frequency electric fields was observed in the recording of nuclear radiations. It was shown that in recording α particles the effect of the field may be used to discriminate the background produced by spurious radiation. (auth)

38457 GRAPHITE CRYSTAL POLARIMETER FOR STELLAR X-RAY ASTRONOMY. Weisskopf, M. C.; Berthelsdorf, R.; Epstein, G.; (and others) (Columbia Univ., New York). Rev. Sci. Instrum.; 43: No. 7, 967-76(Jul 1972).

The first crystal x-ray polarimeter to be used for x-ray astronomy is described. Polarization is measured by modulation of the x rays diffracted at an average 45° glancing angle from large, curved graphite crystal panels as these rotate about an axis parallel to the incident x-ray flux. Arrangement of the crystal panels, the design of the detector, and the signal-processing circuitry were optimized to minimize systematic effects produced by off-axis pointing of the rocket and cosmic ray induced events. The in-flight performance of the instrument in relation to the observed background signal is discussed. (auth)

38458 MECHANICAL PROPERTIES OF VERY THIN POLYMER FILMS. Spivack, M. A. (Union Carbide Corp., Bound Brook, N. J.). Rev. Sci. Instrum.; 43: No. 7, 985-90(Jul 1972).

The uniaxial and biaxial mechanical properties of five thin film polymers used as windows in radiation detectors have been measured. Parylenes N, C, and M exhibit uniform properties to thicknesses as low as 0.12 μ; the 4.3 μ polyester (Mylar) and the 2.3 μ polycarbonate (Kimfol) show tensile and elongation properties inferior to those measured on thicker sections. Biaxial rupture strengths were found to vary directly with film thickness and inversely with the half-power of the unsupported area. The measured rupture constant is shown to be a function of the tensile strength and ultimate elongation of the material. (auth)

38459 TIMING WALK AND TIME RESOLUTION ESTIMATED BY LEAST-SQUARES FITTING. Lerche, R. A.; Wehring, B. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods; 101: No. 3, 599-602(1972).

A least-squares fitting technique is described which uses software to estimate timing walk and system time resolution. It is applied to fission-fragment double-kinetic-energy data taken with silicon surface-barrier detectors. A resolution of 0.40 ns fwhm is reported. (auth)

38460 ABSOLUTE CALIBRATION OF A ^{12}C POLARIMETER FOR DEUTERONS BETWEEN 20 AND 30 MeV. Perrin, G.; Nguyen Van Sen; Fiore, A.; Arvieux, J. (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Instrum. Methods; 101: No. 3, 603-4(1972).

Angular distributions have been measured of asymmetries produced by vector polarized deuterons scattered by ^{12}C at 20.5, 25.2 and 29.5 MeV. The absolute normalization has been performed by comparison with the d$-^4$He elastic scattering at 15 MeV. (auth)

38461 VERY LOW BACKGROUND PROPORTIONAL COUNTER FOR TRITIUM DATING. Povinec, P. (Comenius Univ., Bratislava). Nucl. Instrum. Methods; 101: No. 3, 613-14 (1972).

The preliminary results of background measurements of a proportional counter consisting of seven element inner counters and a ring anticoincidence counter are reported. The background reduction is achieved by an external and internal system of anticoincidence. (auth)

38462 ELECTRONIC COUNTING AND PROJECTION OF ETCHED TRACKS IN SOLID STATE NUCLEAR TRACK DETECTORS (SSNTD). Khan, H. A.; Durrani, S. A. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 101: No. 3, 583-7(1972).

A surface barrier detector coupled with a thin plastic SSNTD has been used to determine moderately high fission fragment fluences, employing beams of alpha particles as probes. An attempt has also been made to use the system for estimation of fission fragment average energies. Also, etched tracks in glasses and thin mica sheets have been optically projected to facilitate visual counting of low track densities. (auth)

38463 DEVELOPMENT OF MINIATURIZED SOLID STATE DETECTORS FOR THE MEASUREMENT OF BETA AND GAMMA RADIATION IN SUPERFICIAL AND DEEP PARTS OF LIVING TISSUE. Lauber, A. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods; 101: No. 3, 545-50(1972).

The construction of two types of miniaturized probes for in-vivo measurement of beta and gamma radiation is described. The probes use cylindrical lithium compensated silicon detectors as sensing elements. The first type is intended for relatively superficial measurements. It consists of a stainless steel tube 50 to 100 mm long attached to a cylindrical holder. The steel tube contains one or several detectors fixed or movable inside the tube. Depending on the size of the sensing elements the outer diameter of the steel tube can be chosen in the interval 1.1 to 4.5 mm. Tube wall thickness is normally 50 μm but can be reduced to 15 μm if required (measurements of low-energetic beta radiation). The second type makes it possible to measure deep inside living tissue. It consists of a detector element similar to that described above but contained in a steel tube 13 mm long and attached to a 50 to 100 cm long, easily flexible coaxial cable. The outer diameter of the structure is of the order of 1.2 to 1.5 mm. (auth)

38464 FAST dc AMPLIFIER WITH AUTORANGING OVER SIX DECADES. Lasser, O.; Fleck, C. M. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods; 101: No. 3, 527-34(1972).

The circuit description and performance of a fast dc amplifier with autoranging over six decades are discussed. The dynamic range consists of six decades from 10^{-9}A to 10^{-4}A full scale and with a maximum rise-time of 280 μs. The reading is linear with an accuracy of better than 0.5% over the full range. No linearity deviations could be measured. Range switching is fast and amplifier gain is varied in powers of 10. (auth)

38465 SOURCE-FOLLOWER LINEARIZATION OF A DIODE PUMP INTEGRATOR. Veselinovic, D. I.; Danilovic, D. Z.; Sobajic, M. V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Instrum. Methods; 101: No. 3, 535-7(1972).

A pulse ratemeter having the advantage, with respect to linearization and temperature stability, over the ratemeter with electronic tubes and bipolar transistors is described. The linearization of a diode pump integrator by a source-follower with a stabilized operating point has been proposed. A range with the full scale deflection of 1 p/s and linearity of 0.1% has been obtained. The rate range includes two linear decades of pulses per second without a change of diode pump circuit elements. (auth)

38466 THREE-DIMENSIONAL DENSITY RECONSTRUCTION FROM A SERIES OF TWO-DIMENSIONAL PROJECTIONS. Goitein, M. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 101: No. 3, 509-18(1972).

An iterative relaxation technique is presented for unfolding three-dimensional distributions from a series of two-dimensional projections taken at several different orientations relative to the object being investigated. The achievable resolution is discussed. Analyses of both computer simulations and actual measurements are presented. This type of analysis has applications in radiography, electron transmission microscopy, radiotherapy, and nuclear medicine. Features of the technique which may make it especially suitable for particular applications are described. (auth)

38467 EQUILIBRIUM CHARGE DISTRIBUTIONS OF LIGHT IONS IN HELIUM, MEASURED WITH A POSITION-SENSITIVE OPEN ELECTRON MULTIPLIER. Hvelplund, P.; Laegsgaard, E.; Pedersen, E. Horsdal (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 101: No. 3, 497-502(1972).

Equilibrium charge distributions have been measured for $2 \leqq Z \leqq 18$ ions with energies from 100 to 400 keV. Equilibrium was established by passing accelerated ions through a helium gas. The different charge states of the beam were separated in an electric field and detected by an open position-sensitive electron multiplier, constructed for this experiment. The results show that the equilibrium charge distribution depends strongly on the atomic number of the projectile and that the mean charge $\bar{\imath}$ is an oscillating function of Z at fixed velocity. For ions with $Z < 10$, the value of $\bar{\imath}$ is larger in helium than after passage through a carbon foil. (auth)

38468 MONTE CARLO CALCULATIONS FOR THIN NaI(Tl) CRYSTALS AT ENERGIES BELOW 100 keV. Sharma, R. C.; Garg, S. P.; Somasundaram, S. (Bhabha Atomic Research Centre, Bombay). Nucl. Instrum. Methods; 101: No. 3, 413-22 (1972).

Monte Carlo calculations are performed to determine the pulse-height response of thin NaI(Tl) right cylindrical crystals to monoenergetic photons of energy less than 100 keV. Comparisons with experimental results obtained with a 38.1 mm diam × 2 mm NaI(Tl) detector and a point isotropic source on its axis show remarkable agreement. The calculated values of total absolute detection efficiency, intrinsic efficiency and peak to total ratio are tabulated for various crystal sizes. Also calculated are the values of iodine escape peak to photopeak ratios for the case of poor geometry at various incident photon energies for thin NaI(Tl) crystal detectors. Data on the energy loss spectra at a few photon energies are included. Remarks are made on the efficacy of generated shapes for unfolding continuous bremsstrahlung spectra. (auth)

38469 COMPARISON OF SOME METHODS FOR TIMING Si(Li) DETECTORS. Hofmann, A.; Philipp, G.; Thomas, K.; Vogler, F. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 101: No. 3, 467-70(1972).

To study the timing behavior of lithium drifted silicon detectors in a counter telescope the methods of leading edge, constant fraction of pulse height and extrapolated zero strobe triggering both with charge and current pulses have been used. The distribution of time signals as a function of the particle energy is investigated for protons, deuterons and alpha particles. (auth)

38470 HALOGEN-DOPED CADMIUM TELLURIDE FOR DETECTION OF GAMMA RAYS. Wald, F. V.; Bell, R. O. (Tyeo Labs. Inc., Waltham, Mass.). Nature (London) Phys. Sci.; 237: No. 70, 13-15(1 May 1972).

The advantages of heavier compound semiconductors, compared with silicon and germanium, for the detection of γ-rays are discussed. In this connection CdTe is of considerable interest. The phase relationships of the solid compound, however, prevent efficient preparation of fully intrinsic CdTe, and some form of compensation is necessary to attain the necessary high resistivity. It has been successfully used for this purpose, and a model is presented to describe the compensating effects of In in CdTe. From this model it was apparent that some other elements should also be effective doping agents, including the halogens. Halogen-doped CdTe was prepared under Te excess conditions, by addition of $CdCl_2$, $CdBr_2$, CdI_2 or CdF_2. It was found that, except for CdF_2, all samples doped with halides at all concentrations were of high resistivity ($>10^6$ ohm-cm) as grown. Radiation detectors were fabricated from the samples and showed efficient γ-ray detection; the best results for γ-ray resolution were achieved with Cl-doped samples. Reasons for the improved behavior are suggested—the trapping cross section is reduced since charge compensation occurs over a smaller volume, and the trap density is decreased since $\sim 10^{15}$ Cl/cm^3 are present instead of $\sim 10^{17}$ In/cm^3. Homogeneity is better, and no heat treatment and quenching are necessary to obtain low carrier concentrations. (UK)

38471 POSSIBILITY OF USING A LIQUID-FILLED IONIZATION CHAMBER IN THE LONG-WAVE X-RADIATION RADIOMETRY. Frolova, A. V.; Kolotilova, V. G. (Scientific-Research Inst. of Rentgeno-Radiology, Moscow). Med. Radiol.; 17: No. 4, 72-5(Apr 1972). (In Russian).

A description of an experimental liquid-filled heptane-containing ionization chamber and its dosimetric characteristics is given. The possibility of utilizing such a chamber for determining the absorbed energy of soft x radiation is shown. (4 figures) (auth)

38472 CHARACTERISTICS OF WALL-TYPE PROPORTIONAL COUNTERS FOR MICRODOSIMETRY. Budenskii, V. G.; Putkevich, V. A.; Farnakeev, V. V. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 17: No. 4, 75-9(Apr 1972). (In Russian).

The characteristics of cylindrical and spherical tissue-equivalent proportional counters for microdosimetry were investigated. The coefficients of gas amplification for methane filling were measured, and a spectroscopic system was calibrated. The spectra of absorbed energy for ^{60}Co gamma radiation and of neutrons from a Pu–Be source for a cylindrical, responsive volume of variable dimensions were obtained. (6 figures) (tr-auth)

38473 NUCLEAR-RADIATION DETECTION AND MONITORING. Sharpe, J. E. M. I. Electron. Power; 18: 156-9(May 1972).

Ionizing radiations cause undesirable chemical and genetic effects. To prevent these, safety regulations are necessary. A wide range of instruments is needed to check that the regulations are enforced. Radiation characteristics of the main types of charged particles are tabulated and discussed. The advantages and limitations of instruments incorporating ion-chambers, G.M. tubes or scintillation counters are considered; and examples described. The measurement of neutron flux is considered. The overall requirements in design of nuclear radiation detection and monitoring equipment are enumerated. (UK)

38474 VOLTAGE-PULSE-PROFILE CHARACTERISTICS WITH SPACE CHARGE OF A LOADED PULSED IONIZATION CHAMBER. Kim, S. H. (Colorado State Univ., Fort Collins); Ellis, W. H. J. Appl. Phys.; 43: No. 7, 3127-31(Jul 1972).

An analytical model describing the voltage pulse profile of a pulsed ionization chamber and its relationship to the electron density in a field drift dominated plasma is formulated. The differential equation derived from the equations of motion and conservation of electron density combined with Poisson's equation for the electric space-charge field in the system is solved analytically for the cylindrical-electrode geometry with an external RC circuit. The numerical analysis for the given initial and boundary conditions yields the anode voltage-signal pulse profiles for the period of electron collection as a function of the initial electron density, the gas pressure, and ion-chamber radii and length. Thus, the theory permits the determination of the electron density from the observed voltage signal. (auth)

38475 SEMI-CONDUCTOR RADIATION DETECTORS: TECHNICAL SURVEY NO. 7. Nucl. Eng. Int.; 17: No. 192, 389-401(May 1972).

The survey comprises three articles which describe the application of semi-conductors as germanium gamma-ray spectrometers, new applications of semi-conductor detectors, and self-powered neutron detectors. Data sheets are also presented which tabulate the characteristics of currently available devices and their manufacturers. Separate abstracts are prepared for each article. (UK)

For abstracts of individual papers see: 38476, 38510, and 38511.

38476 SELF-POWERED NEUTRON DETECTORS. Joslin, C. W. (Reuter-Stokes Canada, Ltd., Ont.). Nucl. Eng. Int.; 17: No. 192, 399-401(May 1972).

The application of self-powered neutron detectors in nuclear power reactors is described. Details are given of their use in-core detectors in flux-mapping systems and in full-power control and safety circuits. The advantages of platinum detectors are discussed, and reference is made to recent interest in detectors for fast-flux environments. (UK)

38477 RADIATION DETECTOR. (to Commissariat a l'Energie Atomique). British Patent 1,276,937. 7 Jun 1972. Priority date 23 May 1969, France.

A multicell (N × n) position-sensitive proportional counter system is described. (W.H.K.)

38478 CLINICAL PROBLEMS IN DETECTION OF RADIOACTIVITY. Smoak, William M.; Weinstein, Morton B.; Smith, Edward M. (Univ. of Miami, Fla.). pp 137-44 of Hematopoietic and Gastrointestinal Investigations with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1972).

From Hematopoietic and gastrointestinal investigations with radionuclides conference; Miami, Fla. (3 Mar 1971).

Evaluations with phantoms indicated that a major factor in the degradation of images is motion induced by normal physiologic activity. An instrument was developed which inhibits recording of scintillations during selectable active portions of the cardiac or respiratory cycle. Liver and lung scans showed that the prone position is better than the supine. The utility of an under-the-table probe is pointed out. Motion is reduced, and the organ is more likely to fall within the effective focal volume of currently available collimators. It was not possible, however, to obtain similar image improvement with the Anger camera. (8 figures) (R.W.R.)

38479 WHOLE-BODY COUNTING OF ^{241}Am AND ^{252}Cf WITH THE ANGER CAMERA. Parker, Howard G.; Wright, Stephen R. (Univ. of California, Berkeley). Health Phys.; 22: No. 6, 891-7(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The Anger scintillation camera has capabilities as a whole-body or large-sample counter that are as yet not widely appreciated. The device is available in more than 800 hospitals. With collimator removed and $\frac{1}{2}$ in. lead shadow-shielding its face, it was found that it gives its maximum performance as a detector of very small amounts of γ-emitting radioactivity. In the energy region 30 to 200 keV it competes favorably in efficiency, minimum detectable activity, and energy resolution with the typical large-volume single NaI crystal detector in a steel room. Among readily available actinides, ^{241}Am and ^{252}Cf are particularly suitable for this type of γ counting. (auth)

38480 SEMICONDUCTOR DETECTORS FOR THE STUDY OF NUCLEAR REACTIONS. Litovchenko, P. G.; Gonchar, V. G.; Barabash, L. I.; Demidova, G. N.; Kibkalo, T. I. (Inst. of Physics, Kiev). Poluprov. Tekh. Mikroelektron.; No. 4, 122-9(1970). (In Russian).

Special detectors were assembled which possessed resolution of 50 to 60 keV for α particles of ^{243}Am where $E_\alpha = 5.8$ MeV. A new construction of end type detectors is described for the spectrometry of charged particles with 3 to 4 mm paths. Cap type i-region detector construction for decreasing the exposed i-region surface is summarized. Ring type detectors are described for the study of the angular distribution of γ rays following Coulomb excitation in which the γ rays are recorded in coincidence with scattered particles at back angles. Detectors based on Li-compensated p-silicon were designed for the determination of charged particle loss (dE/dx-detectors). Surface and noise effects, and volt-ampere characteristics are considered for some of the designs mentioned. (K.S.W.)

38481 CIRCUIT FOR PROCESSING SIGNALS FROM MULTIWIRE PROPORTIONAL CHAMBERS CONSTRUCTED IN THICK FILM HYBRID FORM. Tarle, J. C.; Verweij, H. (CERN, Geneva). Nucl. Instrum. Methods; 102: No. 1, 131-40(1972).

A hybrid circuit for multiwire proportional chambers is described. It provides amplification, discrimination, delay and storage of wire signals. Results of tests on prototypes are given. (auth)

38482 NEUTRON MULTIPLICITY COUNTER. Macklin, R. L.; Glass, F. M.; Halperin, J.; (and others) (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 102: No. 1, 181-7 (1972).

A neutron multiplicity counter assembly has been constructed to enable a search for superheavy elements in natural samples and in accelerator targets. The detector consists of twenty ^{3}He counters placed in a paraffin moderator. These counters surround a central sample cavity with a capacity of about 20 l, capable of accommodating samples up to 100 kg in weight, depending on the density. A particular feature of this counter is its relative insensitivity to gamma rays. The efficiency for detecting a single neutron is ≈30%. An estimate of $\bar{\nu}$, the number of neutrons emitted per fission in a sample, may be obtained from the observed multiplicity distribution P(n), where n is the number of neutron counts in an event. More accurate values of $\bar{\nu}$ may be obtained for small, isolated samples of spontaneously fissioning isotopes, where the neutron counters may be gated by a fission fragment detector. The design of the counter and an analysis of its properties are presented. (auth)

38483 INTERNAL CONVERSION ELECTRON MEASUREMENT USING A β−e AND β−γ COINCIDENCE APPARATUS. Ohya, S.; Tamura, T.; Matumoto, Z. (Japan Atomic Energy Research Inst., Tokai). Nucl. Instrum. Methods; 102: No. 1, 121-3(1972).

An apparatus for measuring the conversion coefficients for strongly beta-fed nuclei has been constructed. The system employs both Si(Li) and Ge(Li) detectors in coincidence mode with a plastic scintillation counter to obtain a beta-suppressed electron spectrum and the corresponding γ-spectrum. The beta background was suppressed by 20 times in a typical example of ^{124}Sb. (auth)

38484 EVALUATION OF FAST-NEUTRON-REACTOR SPECTRA WITH THRESHOLD DETECTORS. Svec, P.; Kadlec, V. (Nuclear Research Inst., Rez, Czech.). Czech. J. Phys.; 22: No. 5, 364-79(1972).

All methods published in the literature which are employed for evaluation of fast-neutron spectra in a reactor by means of threshold detectors are discussed. Mathematical description of selected procedures is presented, and the respective methods are tested on four spectra taken as models. In addition, the effect of the detector selection and of the detector number on the correctness of the resulting spectrum shape is studied in respective evaluation methods, as well as the effect of errors of the detector absolute activities. The following threshold reactions were used: ^{237}Np(n,f), ^{232}Th(n,f), ^{103}Rh(n,n′)^{103}Rh, ^{115}In(n,n′)-^{115}In, ^{32}S(n,p)^{32}P, ^{58}Ni(n,p)^{58}Co, ^{27}Al(n,p)^{27}Mg, ^{31}P(n,p)^{31}Si, ^{56}Fe(n,p)-^{56}Mn, ^{28}Si(n,p)^{28}Al, ^{24}Mg(n,p)^{24}Na, and ^{27}Al(n,α)^{24}Na. All calculations were carried out with the GIER computer. (auth)

38485 GAMMA-RADIATION DETECTORS OF SINTERED CdS. Lakova, M. S.; Stoyanov, V. E.; Kanev, S. K. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 11, 1457-9(1971).

Development of a gamma detector of sintered CdS with satisfactory sensitivity and fast speed of response and produced by using a simple, reproducible technology is discussed. Methods for obtaining sintered pellets of higher resistivity are described; it was found that the heat treatment is of particular importance. A brief discussion of the mechanisms involved on a microscopic level is given. (3 figures) (R.W.R.)

38486 FLOWMETER OF OUR OWN DESIGN FOR MEASUREMENT OF BETA-ACTIVE ISOTOPES. Rozycki, Zdzislaw; Majle, Tadeusz Rocz. Panstw. Zakl. Hig.; 22: No. 5, 611-18(1971). (In Polish).

A flowmeter containing a propane−butane gas mixture working in the proportional amplification range was designed and constructed. Due to a high yield of β particles in the solid angle containing the source and the window of the counter, more advantageous conditions of measurement were obtained than those existing in the use of industrially manufactured window detectors. In comparison with the liquid scintillation method, the yield of the flowmeter is lower, but its application is more convenient. (4 figures, 1 table) (auth)

38487 LITHIUM GLASS SCINTILLATORS FOR NEUTRON DETECTION. Orlov, N. F.; Andreeva, N. Z.; Gerasimov, V. F.; Zenkevich, V. S.; Moskalev, S. S. At. Energ. (USSR); 32: No. 5, 416-19(May 1972). (In Russian).

The characteristics of scintillator glass containing Li are discussed. The conversion effectiveness of glass scintillators and their transparency toward self-radiation were investigated. The amplitude values were studied as functions of molar percent ceria and lithia. The optimum concentration of Ce_2O_3 in the glass was 0.8 mole %; a variation in the concentration of Li_2O between 10 and 30 mole % affected the scintillation properties of the glass very little. The effectiveness of neutron detection by lithium glasses was studied, both with natural Li and with compositions depleted in ^{6}Li. (3 figures, 2 tables) (K.S.W.)

Radiation Dosimeters

Refer also to abstract 38683.

38488 (AERE-R-7009) A.E.R.E. MEASUREMENTS FOR A SIMULATED CRITICALITY ACCIDENT DOSIMETRY EXPERIMENT ORGANISED BY N.R.P.B., JUNE 1971. Delafield, H. J.; Boot, S. J.; Dennis, J. A. (Atomic Energy Research Establishment, Harwell (England)). Mar 1972. 17p. Dep. NTIS (U. S. Sales Only).

Harwell participated in a nuclear accident dosimetry intercomparison organised between various U.K. establishments by the National Radiological Protection Board in which criticality dosemeters were exposed to pulsed radiation from the "VIPER" reactor at A.W.R.E., Aldermaston. It was discovered that the neutron spectrum was different from any previously experienced in that most of the dose was due to intermediate energy neutrons (0.1 eV to 1 MeV). Under these circumstances a reliable neutron dose estimate could not be made by means of the single criticality dosemeter exposed on the man-phantom. A second pulsing of the reactor was arranged, at which both an installed phantom surrounded by criticality dosemeters, and the experimental threshold detector system were exposed. The surface absorbed recoil dose to the front of the man-phantom was estimated to be 323 rads from routine installed dosimetry measurements, and 470 rads from the threshold detector system. The measurement by the film badge of the total surface absorbed gamma dose was 282 rads. With a softer than average neutron spectrum, reliance had to be placed on the sodium-24 measurements for routine personnel dosimetry. Reliable corrections to the observed sodium activity for the effect of thermal and intermediate-energy neutrons could only be made when criticality dosemeters were worn on both the front and back of the phantom. (auth)

38489 (ANCR-1057) REACTOR GAMMA HEAT MEASUREMENTS WITH THERMOLUMINESCENT PHOSPHORS. Tappendorf, J. C. (Aerojet Nuclear Co., Idaho Falls, Idaho). Mar 1972. Contract AT(10-1)-1375. 30p. Dep. NTIS.

The measurement of gamma heat in a critical facility using the thermoluminescent phosphor CaF_2: Mn has proven to be a reliable means of obtaining gamma heat information for test reactors. The small size of the CaF_2: Mn detectors enables detailed measurements without having to remove any reactor hardware to accommodate the detectors. In addition, the phosphor is sufficiently sensitive for irradiations at a reactor power level of approximately 300 watts for 20 minutes. The results of the measurements are reported in terms of gamma heating in aluminum because of the similarity of the energy response to gamma rays for aluminum and the phosphor. The absolute and relative errors for this technique of measuring gamma heat for test reactors are estimated to be ±21% and ±5%, respectively, at 95% confidence limits. (8 figures, 2 tables) (auth)

38490 (SWRHL-93-r) COMPARISON OF FILM BADGES AND THERMOLUMINESCENT DOSIMETERS USED FOR ENVIRONMENTAL MONITORING. Fitzsimmons, Charles K.; Horn, William; Klein, William L. (Western Environmental Research Lab., Las Vegas, Nev.). May 1972. 35p. Dep. NTIS.

Data obtained from two concurrent dosimetry networks operated by the Western Environmental Research Laboratory in Nevada, one utilizing film badges and the other, thermoluminescent dosimeters (TLD's), are compared. Gamma exposures from a few mR to approximately 1 R, due to both natural background and fission products in the environment, are more easily and accurately measured by the TLD system. Where the minimum detectable exposure for film is about 45 mR, the TLD sensitivity is on the order of 1 mR (which allows measurement of monthly background exposures). The insensitivity of TLD's to environmental heating, humidity, light damage, and pressure makes them ideal for use in the extreme conditions encountered in the desert. Heat damage to the film was seasonal with the greatest losses occurring in the summer. During July, 1967, 71% of the film badges issued were heat or light damaged, while no loss of TLD data occurred. No background information was obtained from film data during 1967, but the geographical variations in background exposure rates were clearly disclosed by the TLD's. (10 figures) (4 tables) (auth)

38491 USE OF OPTO-ELECTRONIC CONVERTER WITH SEMICONDUCTOR PHOTOVARICAP IN A DOSIMETRIC APPARATUS. Litovchenko, V. G.; Serba, A. A.; Gorban, A. P.; (and others) (Inst. of Semiconductors, Kiev). Poluprov. Tekh. Mikroelektron.; No. 5, 108-13(1971). (In Russian).

An optoelectronic modulator of constant low-frequency voltages was developed from high-resistance sources by using a photovaricap and a light diode. The modulator was characterized by high frequency parameters (10^5 to 10^7 Hz) and a large input resistance ($>10^{12}$ ohm), but small overall dimensions and low weight. Experimental data illustrating the operation of the circuitry are shown. Use of these opto-electronic modulators raises by several orders of magnitude the modulation frequency as compared with mechanical dynamic capacitors. Common ac amplifiers may be used in place of electrometer input cascades. (5 figures) (tr-auth)

38492 UV DOSIMETER BASED ON THE THERMOLUMINESCENCE OF NATURAL CaF_2. Konschak, K. (Technische Univ., Dresden). Radiochem. Radioanal. Lett.; 10: No. 3, 177-82 (30 May 1972). (In German).

A uv-dosimeter based on the thermoluminescence of natural CaF_2 (activated with Mn) is described. The relation between the measuring efficiency and the quantity of uv light is not linear, and a calibration curve is needed. The evaluation of the uv-dosimeters may be done with any thermoluminescence readout device. (auth)

38493 TWO COUNTER GEOMETRY FACTOR FOR BREMSSTRAHLUNG EXPERIMENTS. Birchall, J. (Univ. Laval, Quebec). Nucl. Instrum. Methods; 101: No. 3, 493-6(1972).

A technique is presented for the calculation of detection of two coincident particles. The technique has been applied to the interpretation of the results of bremsstrahlung experiments, but is sufficiently flexible to be easily applied to other cases. Various detection geometries are considered. The dependence of the bremsstrahlung cross-section on the noncoplanarity of the detected particles is included explicitly in the efficiency calculation. (auth)

38494 4 MeV X-RAY FILM DOSIMETRY. Jacobson, Ahren (Univ. of Louisville, Ky.). Radiology; 103: No. 3, 703-5(Jun 1972).

The successful use of film techniques in high-energy electron and x-ray beam dosimetry was extended to measurements of 4 MeV x rays from a standing-wave linear accelerator. Despite possible nonequilibrium beam conditions, depth-dose and field-uniformity data obtained from film phantom work were found to compare quite favorably with other dosimetric results. (auth)

38495 CHARACTERISTICS OF THERMOLUMINESCENCE DOSIMETERS AS PERSONNEL MONITOR. Nakajima, Toshiyuki (National Inst. of Radiology and Science, Tokyo); Kato, Yoshio; Kato, Jinzo; (and others). Nippon Genshiryoku Gakkaishi; 14: No. 5, 214-21(May 1972). (In Japanese).

Comparisons were made of the characteristics of LiF, natural CaF_2, Mg_2SiO_4(Tb), and $CaSO_4$(Tm) thermoluminescent dosimeters. These dosimeters can be classified into two groups, tissue-equivalent materials and highly sensitive dosimeters. The former, including LiF, were not found suitable as personnel monitors; but the latter, including CaF_2, $CaSO_4$(Tm), and Mg_2SiO_4(Tb), were suitable. The properties of the thermoluminescent dosimeters were compared with those of the pocket chamber, the film badge, and the glass dosimeter. It is concluded from these results that the first-named dosimeters posses useful properties as a personnel monitor. (5 figures, 12 tables) (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 38809

38496 (CEA-CONF-1963) LOW-ENERGY X-RAY SPECTROMETRY USING SEMICONDUCTORS. Friant, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1971. 40p. (In French). (CONF-710525-2). Dep. NTIS (U. S. Sales Only).

From Conference of the French Society of Electronic and Radioelectronic Engineers; Malakoff, France (19 May 1971).

A brief description is given of an x-ray spectrometer using cooled Si(Li) detectors. The different characteristics of the detection head are examined: energy resolution, efficiency, detection threshold; and the possible applications are envisaged. The technology of the Li-compensated Si diodes (<1 pF, inverse current of 10^{-13} A at 77 deg K) and the electronic techniques enabling resolutions of the order of 100 eV to be obtained are described: preamplifier with cooled input stage (FET's with very low noise mounted on ceramic bases) and an optoelectronic negative feedback system (continuous or pulsed). The possibility of detecting x-ray photons at ambient temperature with semiconductor detectors (avalanche diodes, GaAs detectors) is also discussed. (France)

38497 (CEA-CONF-1964) NUCLEAR SPECTROMETRY WITH SEMICONDUCTOR DETECTORS. Fabre, R.; Raoult, N.; Robin, G.; Friant, A.; Hoclet, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 30 Jun 1971. 56p. (In French). (CONF-710824-2). Dep. NTIS (U. S. Sales Only).

From Meeting on the development of gamma spectrometry instrumentation and techniques for safeguards; Vienna, Austria (30 Aug 1971).

A manual on nuclear spectrometry with semiconductor detectors is presented. The precautions to be taken in the use of semiconductors are outlined, and the electronics associated with semiconductor detectors are discussed. The processing of spectra is described. Electronic components of current usage in spectrometers are given, and the most common spectrometers are described. (J.S.R.)

38498 (CEA-N-1514) STABILIZATION CIRCUITS FOR NUCLEAR SPECTROMETRY AMPLIFIERS: PRACTICAL CONSTRUCTION AND SYNTHESIS OF EFFICIENCY CRITERIA. To, Le-Hang (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jan 1972. 108p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Aix-Marseilles Univ., France.

A study on the stabilization of the base line at the output of the amplifiers for a γ spectrometry chain is presented. The first part presents the analysis of the existing stabilization circuits, and the second part concerns the study and realization of a base line stabilizer. The third part offers a comparison between the various circuits according to efficient operation criteria defined for a stabilization circuit. (auth)

38499 (FRNC-TH-179) FABRICATION OF AVALANCHE SCHOTTKY DIODES. APPLICATION TO SOFT X-RAY SPECTROMETRY AND PHOTOMULTIPLICATION. Peyre Lavigne, Andre (Toulouse Univ. (France)). 1972. 203p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Studies were performed on silicon SCHOTTKY barrier diodes. The different processes of fabricating specially passivating methods (oxide, epoxy) and an original method of evaporation for several metals (Cr, Au, Al, Ni; Pb) are described. Each technological process is described with its electrical properties. Also, an original planar technology to obtain an avalanche SCHOTTKY planar diode without guard ring is described. Noise studies show the limits for nuclear spectroscopy detectors and photodiodes. (auth)

38500 PROCESS FOR STABILIZING γ RAY SPECTRA. Pelet, Regis; Bard, J. F. (to Institut Francais du Petrole des Carburants et Lubrifiants). French Patent 2,077,483. 29 Oct 1971. Filed 20 Jan 1970. (In French)

The process and the equipment described are intended (in particular, but not exclusively) for the stabilization of the natural γ ray spectrum of geological formations obtained using a scintillation counter. Local variations in temperature, pressure, and humidity affect this type of experiment. The variations lead to drifts such that the curve representing the intensity of the radiation as a function of the γ energy shifts in an erratic manner in the course of time. This shift occurs in the form of a translation parallel to the abscissa axis; the spectrum itself is not, however, altered by this shift. A reference γ emitter source of known energy is used, which does not introduce a Compton background into the spectrum measured. The procedure is as follows: the detector is exposed to the γ ray source, then to a reference source emitting two different radiations (a reference γ radiation and a different known energy radiation which may be α, β, or γ). This second radiation is detected and the reference γ radiation is isolated; the measurement signals and the stabilization signals are amplified, the measurement signal and stabilization signal gains being linked. Unwanted signals arising from the γ emitted from the reference source are accompanied by another (β, γ) emission from this source, and may thus be easily identified and eliminated from the measured γ spectrum. (France)

38501 SPECTROMETRIC PROPERTIES OF CdTe NUCLEAR RADIATION DETECTORS. Kalugina, L. I.; Pavlova, G. S.; Mitin, V. I.; (and others) (Moscow Inst. of Steel and Alloys). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 9, 1597-1600(Mar 1972).
Translated from Fiz. Tekh. Poluprov.; 5: No. 9, 1836-40(Sep 1971).

CdTe is of interest for radiation detectors because it can be used at room and higher temperatures. Results obtained in a study of spectrometric properties of counters based on junctions prepared by the diffusion of In into n-type CdTe are presented. The resistivity of the original material was 10^5 to 10^7 Ω-cm. The reverse current, junction capacitance, and linearity of the device were determined. ^{241}Am gamma spectra were compared for CdTe and Ge(Li) detectors; the energy resolution of the CdTe detector was about 6 keV. The dependence of the resolution on reverse bias is shown. The response of the detector to alpha particles was also investigated, and the results are presented. (3 figures) (R.W.R.)

38502 USE OF A BENT CRYSTAL GAMMA-DIFFRACTION SPECTROMETER. van Assche, P. Louvain, Belg.; Univ. Louvain (1972). (In Dutch).
Thesis.

Several experiments done by means of a bent-crystal diffraction spectrometer are described. Some characteristics of such a spectrometer are taken up first. Then it is shown that this spectrometer lends itself well to the study of gamma radiation emitted following neutron capture. The nuclei ^{46}Sc, ^{52}V, and ^{56}Mn were studied. Finally, the energy of positron annihilation was measured. (tr-auth) (Belgium)

38503 CURRENT METHOD OF RECORDING MOESSBAUER SPECTRA. Beskrovnyi, A. I.; Ostanevich, Yu. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1320-2(Sep-Oct 1971).
Translated from Prib. Tekh. Eksp.; 14: No. 5, 54-6(Sep-Oct 1971).

With the Moessbauer effect in ^{67}Zn as an example, the advantages and disadvantages of the integral method of recording Moessbauer spectra are discussed. This method allows the use of very powerful γ radiators and, because of this, permits the measurement time to be reduced substantially. The principal requirements governing the recording equipment are considered. (3 figures) (auth)

38504 NUCLEAR GAMMA-RESONANCE SPECTROMETER BASED ON THE AI-256 ANALYZER. Bayukov, O. A.; Ikonnikov, V. P.; Petrov, M. I. (Inst. of Physics, Krasnoyarsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1323-4 (Sep-Oct 1971).
Translated from Prib. Tekh. Eksp.; 14: No. 5, 56-7(Sep-Oct 1971).

A nuclear gamma-resonance spectrometer is described which uses a multichannel AI-256 analyzer operating in the time mode. Instead of a one-channel analyzer the ACB-3 amplitude converter block in the AI-256 is used. The speed drive is designed according to a simplified scheme. (1 figure) (auth)

38505 HIGH RESOLUTION SPECTROMETER SYSTEM WITH PARTICLE IDENTIFICATION FOR 1 THROUGH 60 MeV HYDROGEN AND HELIUM PARTICLES. Bertrand, F. E.; Burrus, W. R.; Hill, N. W.; Love, T. A.; Peelle, R. W. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 101: No. 3, 475-92(1972).

A coincidence semiconductor spectrometer system based on a Ge(Li) total absorption detector has been applied to the simultaneous spectroscopy of all charge 1 and 2 particles from targets bombarded with protons with energy up to 62 MeV. Output spectra cover the range from the full energy down to a 1 to 5 MeV threshold which depends on particle type. The method for choosing the thicknesses for the two ΔE detectors is discussed and unusual features of the system are described. Particles too slow to penetrate the first ΔE counter were sorted according to mass using flight-time vs E discrimination while the more energetic particles were separated using two sets of $\Delta E \times E$ discrimination. Germanium detectors thick enough to stop 60 MeV protons were used with particles entering perpendicular or parallel to the field lines, and in either case the only significant inactive region in the path of the detected particles was the protective foil over the Ge(Li) detector. The typical pulse-height resolution of the system was about 200 keV for 60 MeV protons, although a germanium detector used alone gave 55 keV resolution at this energy. Analysis was performed after the experiments using magnetic tapes written by an on-line computer; corrections to the pulse-height spectra for reaction and collimator tails are discussed. The electronic logic system is described, including portions for event characterization, for use of an "active" detector collimator, and for pileup pulse rejection based on timing information. (auth)

38506 ELECTROSTATIC PRISM SPECTROMETER WITH QUADRUPOLE LENSES. Petrov, I. A.; Shpak, E. V.; Yavor, S. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods; 101: No. 3, 505-8(1972).

The electron-optical diagram of an electron spectrometer consisting of cylindrical lenses forming a prism and quadrupole lenses collimating and focusing the beam is described. Expressions have been obtained for the total spherical aberration of the prism and lenses in the dispersion plane of the spectrometer and in the vertical plane (perpendicular to the former one). Conditions have been derived for correction of spherical aberration of the instrument as a whole by means of octupoles brought into coincidence with quadrupole lenses. A non-telescopic operating regime of the spectrometer has been considered. (auth)

38507 TECHNIQUE FOR DETERMINING BIAS SETTINGS FOR ORGANIC SCINTILLATORS. Knox, H. H.; Miller, T. G. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods; 101: No. 3, 519-25(1972).

The response of NE-213 scintillators to electrons in the energy range from 0.3 to 1 MeV was investigated. The results for a 2 in. diameter × 2 in. NE-213 scintillator indicate that the maximum recoil Compton electron does not occur at the half-height distribution but at 0.89 ± 0.07, the maximum height in the energy range considered. The location of the peak of the Compton distribution was found to be the most accurately defined point of the Compton distribution for the methods used. The peak of the Compton distribution was 4.9 ± 1.7 per cent below the Compton edge while the half-height was 11.7 ± 3.4 per cent above the Compton edge. Results for a 3 in. × 3 in. NE-213 scintillator are also given. Electron energy calibrations of the Compton distribution for ^{22}Na and ^{137}Cs are given to facilitate bias settings for neutron detectors. (auth)

38508 METHOD FOR CALCULATING THE TRANSIENT MODE OF THE VARIANCE OF THE RANDOM OUTPUT SIGNAL OF A LINEAR FILTER BY SWITCHING. Freycenon, J.; Le Hang To; Berbezier, J. (CEN de Cadarache, Paul lez Durance, France). Nucl. Instrum. Methods; 101: No. 3, 539-43(1972). (In French).

A method has been devised to calculate the transient mode of the output noise variance of a filter in the case where, a stationary random noise being applied at the input, the filter transfer function is suddenly modified. The method is used to calculate the signal to noise ratio in a pulse shaping system for nuclear spectrometry using a new type of base line stabilizer. (auth)

38509 ELECTRONICALLY GATED GAMMA AND X-RAY CALIBRATION SCHEME. Forrest, D. J.; Higbie, P. R.; Orwig, L. E.; Chupp, E. L. (Univ. of New Hampshire, Durham). Nucl. Instrum. Methods; 101: No. 3, 567-72(1972).

Gamma and x-ray calibration sources can be made by placing specific radioactive isotopes into small scintillator buttons in which more than 98% of the emitted photons are accompanied by electronic gating pulses. This property allows these sources to be used in a number of different spectrometry calibration schemes without the disadvantage of introducing extra counts into an unknown spectrum of interest. Fabrication techniques and test results for calibration sources using ^{60}Co are given. Also, a closed-loop system using these sources that automatically corrects for gain variations in real time and is designed for a balloon flight and an externally commanded system for a satellite are described. (auth)

38510 LARGE VOLUME GERMANIUM GAMMA-RAY SPECTROMETERS. Frammell, R. C.; Wagner, S. (ORTEC, Inc., Oak Ridge, Tenn.). Nucl. Eng. Int.; 17: No. 192, 389-91(May 1972).

The reasons for the increasing importance of the lithium-compensated germanium detector as a γ-ray spectrometer, which has in many applications virtually replaced the NaI(Tl) scintillation detector, are explained by reviewing the more important performance criteria of γ-ray spectrometers. The characteristics of a typical large Ge(Li) γ-ray spectrometer are described, and future developments are briefly assessed. (UK)

38511 NEW APPLICATIONS OF SEMICONDUCTOR DETECTORS. Gibbons, P. E. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Eng. Int.; 17: No. 192, 391; 396-8(May 1972).

Recent contributions to work on semiconductors are reviewed to show how new devices and experimental arrangements have extended the range of application of semi-conductor detectors. Their use in neutron activation analysis, measurement of environmental radioactivity, and biomedical instrumentation are described. Reference is also made to the semi-conductor, non-dispersive, X-ray spectrometer. (UK)

38512 ART OF LIQUID SCINTILLATION COUNTING. Spencer, Richard P. (Yale Univ., New Haven). pp 145-51 of Hematopoietic and Gastrointestinal Investigations with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1972).

From Hematopoietic and gastrointestinal investigations with radionuclides conference; Miami, Fla. (3 Mar 1971).

The usefulness liquid scintillation counting in clinical nuclear medicine is first discussed. This is followed by a description of the basic theory and techniques used in liquid scintillation counting. (4 figures) (R.W.R.)

38513 MULTI-PURPOSE DATA-HANDLING SYSTEM. Lingeman, E. W. A.; Posthumus, W. L.; Leenaarts, H. W. (Inst. for Nuclear Physics Research, Amsterdam). Nucl. Instrum. Methods; 102: No. 1, 167-80(1972).

A system is described which uses a small digital computer to store beta- and gamma-ray spectra. The computer is also used to process data. The evaluation of the data, stored on magnetic tape, is subsequently performed on a medium large computer (PDP-8). (auth)

High Energy Physics Instrumentation

Refer also to abstract 39101.

38514 (BNL-16856) NON-DISTORTING FILM CLAMP FOR THE MARK II HPD PLATEN. Crennell, D. J.; Strand, R. C. (Brookhaven National Lab., Upton, N. Y.). 6 Jan 1972. 3p. Dep. NTIS.

A non-distorting platen film clamp for correcting systematic shifts in the Mark II HPR is briefly described. (W.H.K.)

38515 (COO-1112-26) THRESHOLD GAS CERENKOV COUNTER FOR A 200 GeV/c BEAM. Yovanovitch, D. D.; Rust, D. R.; Ambats, I. (Argonne National Lab., Ill.); Lundy, R. A.; Pruss, S. M. (National Accelerator Lab., Batavia, Ill.); Akerlof, C. W. (Michigan Univ., Ann Arbor). [1970]. 16p. (ANL/HEP-7104). Dep. NTIS.

The design and performance testing of a prototype helium gas threshold Cherenkov counter for high energy particle identification are described. The emphasis is on testing various photomultipliers with extended quantum efficiency in the ultraviolet. (W.H.K.)

38516 (DESY-72/17) POSSIBILITY OF MEASURING BEBC PICTURES WITH AN HPD. Selonke, F.; Wurth, R.; Brockmann, H. H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1972. 19p. Dep. NTIS (U. S. Sales Only).

From investigations based on the measurement of pictures from the Argonne 12-foot bubble chamber, it is concluded that an HPD with a conventional mercury arc (BH6) illumination system will very probably be suitable for the measurement of BEBC pictures. (auth)

38517 (N-72-14733) DETERMINATION OF THE CHARGE OF RELATIVISTIC HEAVY NUCLEI FROM EMULSION TRACKS. Morgan, S. H. Jr.; Eby, P. B. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). 11 Aug 1971. 16p. (NASA-TM-X-67467; MISC-SSL-71-4). NTIS.

The number of delta rays with energies between 50 and 150 keV that are produced by heavy nuclei in emulsions is calculated. The Z(2) dependence predicted by the first Born approximation is corrected by a direct calculation of the Mott exact phase-shift scattering cross section. Comparisons are made with corrections predicted by the second Born approximation. When the phase-shift results are applied to the problem of charge identification, corrections of up to 4 units of charge for 1.457-GeV/nucleon nuclei with charge Z = 75 are found. (STAR) (auth)

38518 (RHEL/R-247) OPTIMIZING THE PHOTOGRAPHIC VARIABLES OF SPARK CHAMBER FILM FOR AUTOMATIC MEASUREMENT. Lawes, R. A. (Rutherford High Energy Lab., Chilton (England)). Mar 1972. 22p. Dep. NTIS (U. S. Sales Only). UK 25 pence.

The exposure and development of film for measurement on Flying Spot Digitizers has not previously taken into full account the problems peculiar to such devices. The relationship between photographic density and the film transmission changes seen by the Hough Powell Device is discussed. A case study for a spark chamber experiment is presented and the use of an optimization technique demonstrated. (auth)

38519 INDEPENDENT CALIBRATION OF A CHERENKOV SPECTROMETER BY MEANS OF A LIGHT OSCILLATOR. Volodichev, N. N.; Kuzin, Yu. N.; Nechaev, O. Yu.; (and others) (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1317-19(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 51-3(Sep-Oct 1971).

The calibration of equipment designed for prolonged measurement of the extremes of primary cosmic rays is described. (4 figures) (auth)

38520 1.5-m TRACK SPECTROMETER HAVING A HIGH APERTURE RATIO. Aref'ev, A. V.; Bayukov, Yu. D.; Efremenko, V. I.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1325-7(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 57-60(Sep-Oct 1971).

A spectrometer consisting of a spark chamber having the dimensions 150 × 60 × 40 cm in a magnetic field of 1.57 T and a multichannel system of scintillation counters is described. The construction, space resolution, and momentum resolution of the spectrometer are discussed. (4 figures) (auth)

38521 INVESTIGATION OF A MODEL OF A 2-m STREAMER CHAMBER IN THE SKM-200 INSTALLATION. Volodin, V. D.; Glagoleva, N. S.; Karzhavin, Yu. A.; (and others) (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1330-3(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 62-5(Sep-Oct 1971).

The results of investigating a model of a 2-m streamer chamber having two gaps of 4 cm each are described. A generator which produces high-voltage pulses having a stable (at worst 1%) amplitude was used to study the development of streamers which were simultaneously photographed at different angles with respect to the field (0, 20, 30, 90°). A brief description of the equipment used is presented, and the results obtained are discussed. (2 figures) (auth)

38522 SUPPRESSION OF ALPHA-PARTICLE BACKGROUND IN A MULTICRYSTAL SCINTILLATION DETECTOR. Mikailan, L. A.; Afonin, A. I.; Balysh, A. E.; (and others). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 4, 1044-6(Jul-Aug 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 4, 84-6(Jul-Aug 1971).

During the operation of a large multisection scintillation detector designed for the investigation of $\nu - e$ scattering it was established that the background in the 3 to 8 MeV range is determined by α particles from heavy elements which are contained in NaI in the form of impurities. Results are reported which show that this background may be substantially reduced by selecting the pulses in accordance with the rise time. (auth)

38523 CORRECTION OF THE EXTERNAL ORIENTATION ELEMENTS OF PHOTOGRAMMETRIC CAMERAS IN STEREOPHOTOGRAPHY IN TRACK DEVICES. Kozubskii, E. V.; Livshits, E. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1337-9(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 67-9(Sep-Oct 1971).

A method is described for the analytical correction of the external orientation elements of three or more photogrammetric cameras from the points of the working volume of track devices which are photographed by these cameras. The formulas for calculating the corrections to the coordinates of the projection centers of the cameras apply to the normal case of stereophotography. (auth)

38524 USE OF FLASH-TUBE HODOSCOPE CHAMBERS WITH PARTICLE ACCELERATORS. Conversi, M. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Giannoli, G.; Spillantini, P. Lett. Nuovo Cim.; 3: No. 12, 483-9(18 Mar 1972).

The relative merits of spark chambers and flash-tube hodoscopes are first discussed. The latter, with only slight modification, can be employed to advantage in many experiments with particle accelerators. The characteristics of flash tubes studied at Adone are described; sensitive time, recovery time, and probability for a spurious flash were determined. It was found that cylindrical hodoscope chambers containing arrays of the order of 100 flash tubes can be used for 4π geometry experiments by placing them around the crossing region of intersecting beams, even if some 10^6 ionizing particles per second are produced (uniformly) over 4π. The performance of the 2-cm flash tubes was investigated in the presence of a machine background; even at the highest beam intensities attained, tubes placed only a few cm from Adone's vacuum chamber had a probability of flashing spuriously of only a few percent. In a setup with a spark chamber, it was found that a hodoscope chamber had a much greater efficiency as a detector of the many particles involved in electromagnetic showers of 1 GeV total energy. Probably the most serious limitation for the applicability of this technique to accelerator experiments is the comparatively long recovery time, which prevents operation rates in excess of 1/s. For uses where this is acceptable, however, the possibility of using chambers of any size and shape with digitized flash tubes may well represent a simple, flexible, and economical solution. (3 figures) (R.W.R.)

38525 LARGE ELECTROMAGNETIC SHOWER DETECTOR WITH HIGH REJECTION POWER AGAINST PIONS. Basile, M.; Berbiers, J.; Bollini, D.; (and others) (CERN, Geneva. Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna. CNRS, Strasbourg). Nucl. Instrum. Methods; 101: No. 3, 433-54(1972).

A large electromagnetic shower detector for identification and energy measurements of γ-rays (between 150 and 1600 MeV) and electrons (between 400 and 1100 MeV), in the presence of high pion background, is described. The detector is based on the principle of simultaneous measurement of the spatial development of the electromagnetic cascade and of its energy release. It consists of (1) two six-gap thin-plate spark chambers for the reconstruction of the incoming particle trajectories; and (2) nine elements, each made of a lead foil, a spark chamber, and a plastic scintillator, all sandwiched together; here the shower development is studied. When used for γ-detection, a 0.5 cm Pb foil is placed in front of the thin-plate spark chambers, in order to allow the detection of the γ-conversion process and the identification of the γ-direction. The dimensions of the detectors are 60 × 120 cm^2 front face, and 50 cm depth along the electromagnetic shower development. A pion rejection power of the order of 5×10^{-4} between 400 and 1100 MeV, for electron efficiencies varying from 70% to 80%, is obtained. The pion rejection efficiency in the γ-case is highly improved by the anticoincidence efficiency factor, while the γ-detection efficiency depends on the precision required in the reconstruction of the γ-ray direction. The γ-ray and electron energy resolution is about ±15%. (auth)

38526 MARS II: THE OPERATION AND ELEMENTS OF THE SPECTROGRAPH. Ayre, C. A.; Hamdan, M. A.; Hume, C. J.; (and others) (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 102: No. 1, 29-34(1972).

The method of operation of the spectrograph—MARS—is described. The limitations of the triggering system, and of the method of storage of data from the flash-tubes are discussed. The momentum selector incorporated in the spectrograph is considered in detail, and it is shown that there is no rejection of events by the device due to the production of bursts in the iron blocks or to air showers incident upon the apparatus. The events are also considered by equipment which, if the data in the event is suitable, calculates the deflection of the particle traversing the spectrograph using the information available from the momentum selector. (auth)

38527 MARS III: THE STORAGE AND ANALYSIS OF THE SPECTROGRAPH DATA. Thompson, M. G.; Wells, S. C. (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 102: No. 1, 35-44 (1972).

The on-line computing system for the spectrograph—MARS—is described, together with the method of analysis of the data from the flash-tube trays. It is demonstrated that by considering both the flash-tube internal diameters and the separation between the flash-tubes to be 10% greater than their actual measured values, the rate of observance of events, firstly, incorporating a tube which discharged although the ionizing particle did not traverse the tube and secondly, incorporating a tube which did not discharge despite being traversed by an ionizing particle, can be satisfactorily explained. For the oversize tubes and gaps the m.d.m. of MARS is 5850 GeV/c and the events each require on average 40 s of computer time for analysis. (auth)

38528 CHARGE ASYMMETRY MEASUREMENT SYSTEM. Graven, R. M.; Brewer, J. H.; Budnitz, R. J.; McCarthy, R. L.; Miller, D. H. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 102: No. 1, 45-50(1972).

A computer controlled data collection and analysis system was built and used at the Lawrence Berkeley Laboratory's Bevatron to measure the charge asymmetry in the decay $K_L^0 \rightarrow \pi^{\pm}\mu^{\pm}\nu$. The system records the states of 144 scintillation counters arranged into twelve hodoscopes, and it can test the operation of each counter. Information from pulse height analyzers, a digital voltmeter, time-to-amplitude converters, event clock, and scalers were recorded with each event. Using a PDP-9 computer, over 25 million events were recorded on magnetic tape during the tuning and data phases of the experiment. A CRT, programmed to display histograms and geometrical models of the experimental information as it was accumulated, was a valuable diagnostic tool allowing rapid visual assessment of both broad hodoscope and specific counter anomalies. The computer's power was greatly expanded by the addition of external control registers, hardware priority resolvers, event matrix logic, additional programmable flags, and input—output transfer request lines, in addition to software priority levels and the usual program interrupt line and peripherals. Inexpensive dual discriminators, nanosecond coincidence gates, testing circuits and new packaging methods were all used in developing this system. (auth)

38529 MARS I: THE GEOMETRICAL CHARACTERISTICS OF THE DURHAM MAGNETIC AUTOMATED RESEARCH SPECTROGRAPH. Ayre, C. A.; Hamdan, M. A.; Hume, C. J.; (and others) (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 102: No. 1, 19-28(1972).

The new 300 t vertical spectrograph of the University of Durham is described. The spectrograph utilizes neon flash-tubes for particle trajectory defining purposes and the data from the tubes are fed directly into an on-line computer. The maximum detectable momentum of the spectrograph is 5850 GeV/c, and the ratio of the rms scattering angle to the magnetic deflection is 10%. A momentum selector is incorporated in the instrument with a low momentum cut off of approximately 200 GeV/c. The value of $\int Bdl$ is 8.09×10^6 G cm, and each of the two sides of the spectrograph has an acceptance of (408 ± 2) cm^2 sr for particles of infinite momentum. The rate of transversal of muons through each side of the instrument is in excess of 2×10^4 per day. (auth)

38530 MIRABELLE BUBBLE CHAMBER AT THE SERPUKHOV ACCELERATOR. Bertelo, A. (CEN, Saclay, France); Sulyaev, R. M. At. Energ. (USSR); 32: No. 5, 371-8(May 1972). (In Russian).

A description of the physical and operating characteristics of the Mirabelle bubble chamber at Serpukhov is presented. The usual operating liquid is liquid hydrogen at about 27°K, and the operating pressure is changed reversibly between 5 and 2 atmospheres. Cutaway and schematic views of the components are shown. (4 figures) (K.S.W.)

38531 EXPERIMENTAL APPARATUS TO STUDY THE INTERACTION OF π^+ MESONS IN ^{4}He. Busso, L. (Univ. Turin. INFN, Turin); Costa, S.; Garfagnini, R.; (and others). Nucl. Instrum. Methods; 102: No. 1, 1-5(1972).

The experimental apparatus exposed to the positive pion beam of the LEALE Laboratory of Frascati is described. It consists in a diffusion cloud chamber filled with helium at the pressure of 15 atm. Also, the results of the μ^+ and e^+ contamination and energy distribution of the π^+ beam are reported. (auth)

Radiometric Instruments

Refer also to abstract 38486.

38532 (TID-25986) CENTRAL SIERRA PROFILING SNOW GAGE: A GUIDE TO FABRICATION AND OPERATION. Smith, James L.; Halverson, Howard G.; Jones, Ronald A. (Forest Service, Berkeley, Calif. Pacific Southwest Forest and Range Experiment Station). Feb 1972. Contract AT(49-11)-2773. 53p. Dep. NTIS.

Studies at the Central Sierra Snow Laboratory in California have produced a remotely operated radiometric snow gage with which snowpacks may be profiled. A 10-mCi ^{137}Cs source and an NaI scintillation detector are employed. Snowpack density and depth are printed in gm cm^{-3} and hundredths of feet from ground line to snow-air interface. Water content can be computed from the data. Detailed instructions are given for manufacture, calibration, operation, and data reduction. (auth)

38533 (TID-25987) DEVELOPMENT OF A RADIOACTIVE ISOTOPE PROFILING SNOW GAGE. Smith, James L.; Halverson, Howard G.; Jones, Ronald A. (Forest Service, Berkeley, Calif. Pacific Southwest Forest and Range Experiment Station). Feb 1972. Contract AT(49-11)-2773. 88p. Dep. NTIS.

Since 1909, when the technique of snow surveying to determine water content of the snowpack was developed, many gravimetric methods have been designed and used. At the U. S. Forest Service's Central Sierra Snow Laboratory in California, seven generations of profiling snow gages using radioactive isotopes that have been developed and used are described. The final product is a twin-probe gage with which a snowpack of any depth can be profiled. Both density in gm cm^{-3} for each one-half inch and depth of each location in hundredths of feet are printed on a paper tape. Calibration equations have been solved. The gage can be used for streamflow forecasting from snowmelt and for studies in snow hydrology. (auth)

38534 DEVICE FOR MEASURING THE DENSITY OF MOVING CRYOGENIC FLUIDS BY β RAY ATTENUATION. Astruc, J. M.; Perroud, Paul; Foucou, Julien; Veyrat, J. F. (to Commissariat a l'Energie Atomique). French Patent 2,080,134. 18 Oct 1971. Filed 24 Feb 1970. (In French)

A practical device for measuring the density of a low temperature fluid (principally liquid hydrogen or liquid hydrogen–solid hydrogen slush) by β ray attenuation is presented. The device incorporates a tube section containing the fluid, a stepped β ray source, and a detector which are aligned and placed on each side of the tube section. The short tube is provided with two flat thin walls perpendicular to the source/detector alignment plane, mechanically reinforced by grids which define passages parallel to this plane. Grids are interposed between the tube section and the detector and the detector and the source. (France)

38535 IMPROVEMENTS IN AND RELATING TO DENSITY-MEASURING APPARATUS. Parkinson, Michael John (to Coal Industry Ltd.). British Patent 1,274,213. 17 May 1972. Filed 5 Jun 1968.

Reference is made to apparatus for measuring density by β-particle absorption. It is found, in some cases, that the apparent density depends on the geometry of the set-up, in that the measurement shows an increased value as the distance between object and detector increases due to scattering of the particles. This may be overcome by use of a suitable collimator. The collimator described consists of tubes constructed of materials that contain substantially no quantity of any element of atomic number > 13, in order to keep γ-emission low. Polythene or PVC are suitable materials. The β-particle detector is preferably a photomultiplier used in conjunction with a scintillator. Methods of use are also described. (UK)

38536 MATERIAL LEVEL DETECTOR. Shoemaker, David John (to Industrial Nucleonics Corp.). British Patent 1,273,183. 3 May 1972. Priority date 13 Aug 1968, United States.

A radiometric level indicator for fluent substances in conduits or receptacles is described. In order to prevent false signals due to the random nature of radioactivity, the invention includes a "dead" region of no response. The level must change from one side of this region to the other before the device produces a signal that the level has changed. Schematic diagrams of the required electronics are included. (4 figures) (R.W.R.)

38537 IONIZING RADIATION APPARATUS AND METHOD FOR DISTINGUISHING BETWEEN MATERIALS IN A MIXTURE. Slight, David Laurie. U. S. Patent 3,655,964. 11 Apr 1972. Filed 6 May 1968.

A mixture of materials in substantially homogeneous form was subjected to radiant energy at or including a number of different energy levels while the mixture was in motion to monitor and/or determine the composition of the mixture. Response of the mixture to different energy levels was determined and compared with the response from materials of standard composition indicating coincidence with and/or departure from the standard. The difference in response of the detector can also be coupled with a device to divert or let pass certain of the different materials to achieve actual sorting of the mixture. (B.L.M.)

38538 NUCLEONIC GAUGES HAVING SOURCE WINDOW PROTECTOR PLATES WITH COMPRESSED AIR WIPE ARRANGEMENTS FOR USE IN OIL SPRAY ENVIRONMENTS. McMullen, James M.; Berg, Douglas A. (to Industrial Nucleonics Corp.). U. S. Patent 3,662,174. 9 May 1972. Filed 15 Dec 1969.

A nucleonic gage for use with moving strip or web material in which oil particles or oil mist is entrained with the web is described. The nucleonic gage incorporates protector plates, there being one plate associated with the source housing and another plate associated with the detector housing. Each plate includes air passageways through which air is directed under pressure at a region closely adjacent the source window and the detector window for preventing the occurrence of oil droplets or other foreign material on these windows. The plates further provide mechanical protection against window damage in the event that there is a break in the sheet material. (9 figures) (auth)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

Refer also to abstracts 38551, 39117, and 40125.

38539 (NP–19334) RADIATION EFFECTS IN PROPORTIONAL CHAMBERS. Ash, W.; Coignet, G.; Favier, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 1 Feb 1971. 14p. Dep. NTIS (U. S. Sales Only).

The results of some studies on the deterioration of proportional chambers exposed to intense beams and sources are reported. Using the "magic" gas (argon + isobutane + freon), it appears that proportional chambers develop discharges which seriously limit performance after exposure to very large particle fluxes. (W.H.K.)

38540 (SC-DC–722275) EMP RESPONSE OF A CAVITY. PART I. Mangan, D. L.; Scrivner, G. J. (Sandia Labs., Albuquerque, N. Mex.). [1972]. 10p. Dep. NTIS.

The electromagnetic response of a cavity driven by a radiation pulse must be understood to design reliable instrumentation and electromagnetic sensitive devices that must perform in intense radiation fields. To acquire an understanding of EMP cavity excitation a simple model was formulated in such a manner that an exact analytical solution could be obtained. The configuration was a finite-length cylindrical cavity having perfectly conducting boundaries and filled with a homogeneous medium characterized by time-independent conductivity, permittivity, and permeability. The radiation impinges on one of the end faces and thus produces an axially driven current. The model is solved, and the structure of the resultant equations reveals damping of the electromagnetic response and alteration of the characteristic response frequencies due to finite conductivity. The principal difference between the electric and magnetic response solutions is that the nature of the model problem allows the establishment of a quasi-static electric field. Numerical results were obtained for a cavity with a length-to-radius ratio of 0.4. (3 figures) (R.W.R.)

38541 (SC-DC–722276) EMP RESPONSE OF A CAVITY. PART II. Scrivner, G. J.; Mangan, D. L. (Sandia Labs., Albuquerque, N. Mex.). 1972. 12p. Dep. NTIS.

The electromagnetic response of a finite-length cylindrical cavity excited by an axially driven radiation-produced current density pulse is investigated. The cavity has perfectly conducting boundaries and is filled with a homogeneous medium characterized by time-independent conductivity, permittivity, and permeability. The problem is solved by perturbation techniques. Time dependence is separated from space dependence, and the effects caused by inclusion of conductivity appear only in the time-dependent term. None of the approximations exhibits the wave nature previously found in the exact analytical solutions. Numerical results were obtained for a cavity with a length-to-radius ratio of 0.4. (3 figures) (R.W.R.)

38542 (UCRL–51199) ON GENERAL ELECTRODYNAMIC RECIPROCITY, WITH APPLICATION TO THE ANALYSIS OF EMP PROBLEMS. Bevensee, Robert M. (California Univ., Livermore. Lawrence Livermore Lab.). 6 Mar 1972. Contract W-7405-eng-48. 23p. Dep. NTIS.

A general reciprocity theorem is developed for a volume of space containing closed regions of matter, on the surfaces of which it may be difficult to satisfy boundary conditions. The media everywhere are assumed to be linear and inhomogeneous and perhaps anisotropic (but not gyrotropic) in general. The reaction of the interior closed regions upon the outer volume is represented by (self-consistent) surface distributions of electric and magnetic surface currents just outside the volume. The formalism is applied to scattering by a perfectly conducting obstacle, and scattered fields are expressed in terms of incident fields of sources and electric surface currents generated outside the volume of interest. However, it is shown how both electric and magnetic surface current distributions are required for the exact solution. It is then shown how a well-known variational formula for a scattered electric field (in terms of electric surface currents alone) is correct despite the presence of magnetic surface currents. Finally, a procedure is given for calculating EMP-induced voltages within a well shielded enclosure of general shape containing occasional apertures. By reciprocity, this approach relates those voltages to measured and calculated fields on the apertures. To obtain the approximate EMP-induced aperture fields, one first calculates from a variational expression the fields which would be generated on electrically shorted apertures and then deduces, by perturbation theory, the fields present after the apertures are cut. (4 figures) (auth)

38543 EFFECTS OF RADIATION ON THE NOISE PERFORMANCE OF TRANSISTORS. Lauritzen, Peter O. (Univ. of Washington, Seattle). IEEE (Inst. Elec. Electron Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 321-6(Apr 1972).

The predominant transistor noise sources are surveyed and related to both surface and bulk permanent-damage radiation effects. The medium- and high-frequency noise performance of FET and bipolar transistors is not strongly affected by radiation until the devices themselves begin to fail. Low-frequency 1/f noise is affected by relatively light radiation doses, but only with the junction FET can one make quantitative predictions of post-radiation noise performance. An additional noise source of very large amplitude is present while radiation-induced photocurrent is being generated in transistors. (2 figures, 1 table) (auth)

38544 EFFECTS OF NEUTRON RADIATION ON SEMICONDUCTOR DIODES. Morishima, Hiroshige (Kinki Univ., Osaka); Niwa, Takeo; Kawai, Hiroshi; Murakami, Yasuhiro. Kinki Daigaku Genshiryoku Kenkyusho Nenpo; 8: 7-11(1970). (In Japanese).

The influences of neutron exposure and temperature change on the characteristics of semiconductor diodes were studied. The forward-direction resistances of silicon alloyed junction diode and point contact diode after 480 hours exposure of Pu–Be neutron flux (1.4×10^6 n/sec) somewhat decreased, while that of silicon diffusion junction diodes did not change markedly. These measurements were made at several temperatures (−20 to 40°C). The reverse-direction resistance of germanium junction diode decreased remarkably at the same exposure. (auth) (Japan)

Miscellaneous Instruments and Components

Refer also to abstracts 38360, 38425, 38508, 40117, 40124, 40428, and 40433.

38545 (ANCR–1062) IN-CORE EDDY-CURRENT MEASUREMENTS OF THE ATR FUEL ELEMENT CHANNEL SPACING. Prestridge, F. L.; Stanley, M. L. (Aerojet Nuclear Co., Idaho Falls, Idaho). Apr 1972. Contract AT(10-1)-1375. 19p. Dep. NTIS.

During the Core I tests, or first power tests of the Advanced Test Reactor, it was necessary to measure coolant channel thickness spacing in selected fuel elements. A nondestructive testing technique has been adapted and used successfully to make this difficult underwater measurement, restricted by small space, thermal gradients, a radioactive environment. Measurements had to be made in-core with standby coolant water flowing while the elements were still giving off a considerable amount of decay heat. These requirements imposed the following restrictions on the measuring transducer: It had to be small enough to be inserted in a channel as small as 0.055 inch thick; range up to 0.120 inch; have good resolution, low radiation sensitivity, an output independent of temperature, and produce highly repeatable measurements. The transducer chosen was an eddy-current type using phase demodulation techniques to separate unwanted signals. The technique has proved itself in field applications and opened the way for future use of this transducer type in many severe environments. (auth)

38546 (BNWL-SA–4236) OPTIMIZATION OF EDDY CURRENT FLOW METER PERFORMANCE. Sheff, James R.; Lessor, Delbert L. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. 4p. (CONF-720607–13). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

A method for the combination of numerical and perturbation theory solutions of the equations describing eddy current flowmeters for optimizing flowmeter response to flow and bubble detection in a liquid sodium fast reactor environment is briefly described. (W.H.K.)

38547 (BNWL-tr–70) DETECTION OF MULTIPLE ELECTRON EMISSION BY MEANS OF A SCINTILLATION COUNTER. Greupner, H.; Gaworzewski, P. Translated by J. J. Stoffels (Battelle Pacific Northwest Labs., Richland, Wash.), from J. Mass Spectrom. Ion Phys.; 3: 365-70(1969). 6p. Dep. NTIS.

An arrangement is described, based on the principle of the ion-electron converter of Schütze–Bernhard. The suitability of this arrangement for the measurement of probability distributions of ion induced electron emission and for the detection of small ion currents is discussed. In the case of single electrons with an energy of 23.2 keV a detection probability of 98% was determined. In the case of bombardment of a copper target by cesium ions with an energy of 13.2 keV a detection probability of 98.3% was found for ion detection. The smallest detectable ion current is 2×10^{-20} A. (auth)

38548 (CEA-CONF–1978) UNIT OF CONVERSATIONAL GRAPHIC VISUALIZATION: APPLICATION TO NUCLEAR PHYSICS. Morvan, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 10 Feb 1972. 17p. (In French). (CONF-720118–1). Dep. NTIS (U. S. Sales Only).

From Society of Users of the International Company for Information conference; Paris, France (6 Jan 1972).

The techniques of graphic visualization are reviewed from the viewpoint of their exploitation. The conversational graphic visualization unit of the Department of Nuclear Physics at Saclay is then described in detail. (J.S.R.)

38549 (CEA-R–4251) SYSTEM FOR DATA ACQUISITION AND TELEPROCESSING CONTROLLED BY A SMALL COMPUTER. Le Sourne, Mathurin (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar 1972. 135p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Grenoble Univ. (France). Faculte des Sciences.

A teleprocessing system capable of automatically acquiring experimental nuclear physics data and rapidly processing them by computer has been installed at the Grenoble nuclear research center. The system consists of an IBM 360-50 computer and a small computer, CII 90-10. The small computer is connected to the IBM machine in a parallel mode and serves to supervise a rapid serial transmission network. The network is capable of transmitting useful information at the rate of 12.10^4 bauds; it consists of a number of stations scattered over the research center to which small computers, multichannel analyzers, or typewriters can be connected. The software for this system consists of two packages, one for the small computer, CII 90-10, and the other an addition to the O.S. 360 for supervising the data transfers. The objectives sought were: a means of transferring data to the disks of the processing computer; a system for controlling the editing of recorded data; a possibility of using the cataloged library program to process the data; and a typewritten or CRT display of the results. (auth)

38550 (CISE-N–150) ARITHMETIC UNITS FOR DISPLAY. Dotti, D. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb 1972. 24p. (In Italian). Dep. NTIS (U. S. Sales Only).

A specialized arithmetic unit for the visualization of experimental data from a neutron spectroscopic experiment in the Ispra CCR was developed. This unit calculates the neutron diffraction coefficient within crystals as a ratio between the refracted intensity I and the incident intensity M. The ratio is calculated as a function of the angle of diffraction and of the ambient temperature. A background term, previously obtained as the ratio I/M measured in the absence of the refracting agent, is substracted. The calculation, made with hybrid analog digital technology, gives the value of the coordinate z by an oscilloscopic visualization in isometric projection. (tr-auth)

38551 (CONF-720607–14) BEHAVIOR OF A W–Re CENTERLINE THERMOCOUPLE IN A $(U-Pu)O_2$ FUEL PIN. Shepard, R. L.; Fitts, R. B.; Robertson, H. E.; Hyland, R. F. (Oak Ridge National Lab., Tenn.). [1971]. 3p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

A six-inch-long LMFBR-type (85% UO_2 + 15% PuO_2) instrumented fuel pin, clad in 0.25-in OD type 316 stainless steel was irradiated in the ORR for over 330 hours. The centerline temperature of the fuel was measured with a hafnia-insulated W3Re/W23Re thermocouple in a wrought W–26 Re well. The decalibration of the thermocouple was measured, and the results are briefly discussed. (W.H.K.)

38552 (INR–1371) ANALYSIS OF THE GAIN STABILITY AND LINEARITY OF AN ACTIVE ELECTRONIC CIRCUIT WORKING WITH LARGE SIGNALS. Bayer, Ryszard (Institute of Nuclear Research, Warsaw (Poland)). 1972. 175p. (In Polish). Dep. NTIS (U. S. Sales Only).

The method of the analysis, of an active electronic circuit, working with large signals, based on the determination of the temperature and dynamic changes of a particular circuit parameter and the determination of the reduction coefficient value of this parameter has been proposed. The method enables to determine the overall temperature stability and linearity of the gain of a circuit working with large signals. It allows also to determine the significance and the influence of the value of a particular parameter on the proper circuit work. Verification of the proposed method is made with the help of the analysis of two commonly used circuits, such as emitter follower and source follower. The influence of the input signal dynamics (the amplitude range of the input signals) on the signal amplitude transmission linearity of these circuits is examined and the analysis of the temperature stability of the circuit parameters is done. The results of the theoretical analysis are compared with the results obtained experimentally. Very good agreement of the experimental and theoretical results is achieved. (auth)

38553 (KAPL-P-3946) SPECTROMETER FOR MEASURING SECONDARY ELECTRON YIELDS INDUCED BY ION IMPACTS ON THIN-FILM OXIDE SURFACES. Dietz, L. A.; Sheffield, J. C. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1970]. Contract W-31-109-eng-52. 17p. Dep. NTIS.

A spectrometer for studying secondary-electron yields from ion-to-electron converter dynodes is described. It consists of a 5-cm radius, 90° mass spectrometer which is electrically floating, followed by a post-accelerating lens to increase the impact energy of mass-analyzed ions up to 30 keV before they strike an ion converter dynode. Ions are formed by surface ionization. The ion converter dynode is a flat, narrow strip whose surface coincides with the axis of a cylindrical lens and is rotatable about this axis. Secondary electrons are accelerated to 30 keV in the cylindrical lens and are focused onto a silicon solid state detector and undergo pulse-height analysis. Individual secondary electron groups containing 1,2,3, . . ., etc., electrons are resolved from each other and are recorded in a 400 channel pulse-height analyzer. Deconvolution of the resulting energy spectrum leads to precise estimates of secondary-electron yields for monatomic or polyatomic ions of different mass, atomic number, velocity and angle of entry into a given target surface. Typical experimental results are given. (auth)

38554 (LA-4935) PULSED PIEZORESISTIVE GAUGE BRIDGE. Fullwood, Ralph R. (Los Alamos Scientific Lab., N. Mex.). May 1972. Contract W-7405-eng-36. 8p. Dep. NTIS.

A piezoresistive gauge bridge operating in a NIM configuration is described. It achieves a sensitivity of 1 or 0.5 V/% resistance change by using a pulse of 200 or 100 V respectively, to interrogate the gauge. A bipolar line driver capable of ±20 V, and having a gain of 0.95 driving 50 Ω, supplies the bridge output to recording equipment. The maximum risetime of the bridge is 50 nsec, the settling time is 200 nsec, the turn-off time is 1 μsec, and the time delay following an external trigger is 400 nsec. A mathematical analysis of the operation of the pulsed piezoresistive gauge bridge is presented with a comparison of results to calculations. The effect of remotely coupling a gauge to the bridge by a lossy transmission line is presented as well as compensation of this effect by a second equally lossy line. (auth)

38555 (NYO-3906-13) ULTRASONIC THERMOMETRY FOR LMFBR SYSTEMS. Final Report. Papadakis, E. P.; Lynnworth, L. C.; Patch, D. R.; Carnevale, E. H. (Panametrics, Inc., Waltham, Mass.). Jun 1972. Contract AT(30-1)-3906. 167p. Dep. NTIS.

An ultrasonic thin wire thermometer system was designed to measure temperature in liquid metal fast breeder reactors, in the fuel pin, along the fuel centerline. In Phase I, the system was laboratory-tested to 2750 C by simulating the geometry and temperature environment. In Phase II, a magnetostrictive transducer was tested for over 600 hours above 500 C in the Bulk Shielding Reactor at Oak Ridge National Laboratory, and lines were built for in-core comparison tests with thermocouples (ORTC-4). The decalibration effect of 5, 10 and 15% Os in a Re matrix was determined to 2000 C, out of pile. In Phase III a 1.5 mm OD sheathed probe was built and tested to 2200 C in a geometry essentially duplicating the FFTF fuel pin. A Re sensor was also thermally cycled inside a W/Re sheath to 2650 C. In some cases lines tend to bond to the sheath. Measurements of sound velocity, attenuation, temperature profile and resolution to about 2 C using reverberations in the sensor are also described. (auth)

38556 (RISO-M-1467) ELECTRONICS DEPARTMENT SEMI-ANNUAL REPORT FOR THE PERIOD 1 APRIL 1971-30 SEPTEMBER 1971. (Danish Atomic Energy Commission, Risoe. Research Establishment). Feb 1972. 20p. (R-1-72). Dep. NTIS (U. S. Sales Only).

The activities of the department in the fields of instrumentation for Risø experiments, systems techniques, nuclear geophysical methods, and maintenance and construction are reviewed. Publications and lectures by staff members are listed. (auth)

38557 (UCRL-73711) ANALOG DETECTION OF MASS SPECTROMETER PEAKS IN A MULTI-USER COMPUTER SYSTEM. Pomernacki, Charles L. (California Univ., Livermore. Lawrence Livermore Lab.). 17 Apr 1972. 6p. (CONF-720516-5). Dep. NTIS.

From Digital Equipment Computer Users Society Spring symposium; Boston, MA. (11 May 1972).

Mass spectrometer data appear in the form of Gaussian-shaped peaks. Typically, the peaks are several tenths of a second wide and are imbedded in noise. The dynamic range of the peaks may be as high as a thousand to one. The instrument we use is a Nuclide high-resolution mass spectrometer (although it is used in the low-resolution mode when interfaced with a computer). The problems of interfacing peak-detection and signal-conditioning equipment to a multi-user computer for the purpose of handling mass spectrometer data are considered. The techniques described are also applicable to minicomputer users since, in essence, data are reduced to ease system and software demands on a small machine. (auth)

38558 INFORMATION STORAGE USING INHIBITED CATHODOLUMINESCENCE. Bishop, H. E.; Henderson, R. P.; Iredale, P.; Pooley, D. (Atomic Energy Research Establishment, Harwell, Eng.). Appl. Phys. Lett.; 20: No. 12, 504-6(15 Jun 1972).

It is shown that reversible information storage in crystals can be achieved using the inhibition of cathodoluminescence by defects produced by electron irradiation. Since an electron beam of constant energy is used to access the store and to execute the binary operations of write, erase, and read, the addressing problems are minimized. The writing and erasing times are on the order of a few microseconds, and the reading time can be a few hundred nanoseconds. (auth)

38559 ON-LINE COMPUTER CONTROL OF DIFFERENTIAL SCATTERING MEASUREMENTS ON ION-ATOM COLLISIONS. Strechinsky, M.; Abignoli, M.; Baudon, J. (Paris Univ., Orsay, France). Nucl. Instrum. Methods; 101: No. 3, 427-31(1972).

A description is given of an instrumentation for automatic control of an apparatus used in differential ion-atom scattering experiments. The instrumentation includes an on-line PDP-8/I computer. Details are given of the principle of the interface and of the operations with the computer. (auth)

38560 P.H.A. TEST METHOD UTILIZING A PSEUDORANDOM NOISE SIGNAL. Abbattista, N.; De Giorgio, A.; Marino, D.; Plantamura, V. L. (Istituto di Fisica, Bari, Italy). Nucl. Instrum. Methods; 101: No. 3, 589-98(1972).

A P.H.A. test method utilizing a special pseudorandom noise generator to simulate the work conditions is proposed. This method allows nonlinearity measurements as well as channel profile determination with high resolution independently of the channel width. (auth)

38561 GEOMETRIC FACTOR OF A CYLINDRICAL PLATE ELECTROSTATIC ANALYZER. Johnstone, A. D. (Goddard Space Flight Center, Greenbelt, Md.). Rev. Sci. Instrum.; 43: No. 7, 1030-40(Jul 1972).

A method for calculating the geometric factor of cylindrical plate electrostatic energy analyzers with various detector geometries is described. The effects of the fringe field are estimated. For a special simple case an exact geometric factor is calculated, enabling an estimate to be made of the inaccuracies of the approximations used in other cases. The results of some calculations are presented, and a simple approximate expression for the geometric factor is deduced. (auth)

38562 CONTINUOUS SCANNING METHOD FOR ANGULAR CORRELATION MEASUREMENT OF POSITRON ANNIHILATION GAMMA USING MULTIPLE CHANNEL ANALYZER. Jan, G. J.; O'yang, J. Y.; Tseng, P. K.; Liaw, H. B.; Young, C. S. (National Taiwan Univ., Taipei). Chin. J. Phys. (Taiwan); 9: No. 2, 62-7 (Oct 1971).

A new automatic angular correlation measurement method for gamma-ray pairs arising from positron annihilation is described. An arm of a goniometer used in the angular correlation experiment is programmed to sweep an arc of a definite angle continuously. The angular displacement of the moving arm is converted to d.c. voltage and fed to the ADC of a multichannel analyzer as a sampling signal. The coincidence pulses of two gamma rays serve as sampling commands and are stored in the multichannel analyzer as a function of the sampling d.c. signal, e.g., the angular displacement of the goniometer arm. The method makes it possible to set up an inexpensive reliable measurement system. With minor modification it can also be applied to other experiments. (4 figures) (auth)

38563 PROCEEDINGS OF THE 20th RELAY CONFERENCE, STILLWATER, OKLAHOMA, APRIL 18–19, 1972. Scottsdale, Ariz.; National Association of Relay Manufacturers (1972). 142p. $10.00. (CONF-720424).

Seventeen papers were presented on the design, operation, and use of mechanical and solid-state relays. Fluidics is discussed an an alternative to relays. (R.W.R.)

38564 STEREOROENTGENOGRAMMETRY IN THE CLINICO-DOSIMETRIC PRETREATMENT OF PATIENTS BEFORE IRRADIATION. Shiller, B. F.; Kvasov, V. A. (Inst. of Oncology, Moscow). Med. Radiol.; 17: No. 4, 69-71(Apr 1972). (In Russian).

A stereoroentgenogrammetric unit is described, and questions concerned with its use in the course of a clinico-dosimetric pretreatment of the patient for irradiation are discussed. (4 figures) (auth)

38565 DIGEST OF TECHNICAL PAPERS. VOLUME XV. 1972 IEEE International Solid-State Circuits Conference, Philadelphia, February 16–18, 1972. Winner, Lewis (ed.). IEEE Cat. No. 72 C 3–ISSCC. New York; Institute of Electrical and Electronics Engineers, Inc. (1972). 255p. (CONF-720211).

Summaries of 100 papers are presented. Session topics include memory; optical circuits and sensors; microwave power amplifiers; computer aids for layout and analysis; frequency selective circuits; integrated logic circuits; optical display and storage techniques; automotive and tv electronics; technology—economic assessment; charge-transfer devices; analog and A/D circuit techniques; microwave transistors, modulators, and mixers; monolithic amplifier techniques; new device and circuit techniques; and avalanche diodes. An author index is included. (W.H.K.)

38566 MASS SPECTROMETER HAVING MEANS COMPENSATING ELECTRON TRANSIT TIME ACROSS THE CATHODE OF THE ELECTRON MULTIPLIER. Damoth, Donald C.; Shriner, Ham H. (to Bendix Corp.). U. S. Patent 3,660,654. 2 May 1971. Filed 15 Sep 1969.

To improve the resolution of a mass spectrometer, the emissive surface of the cathode for the electron multiplier is precisely angled with respect to the plane perpendicular to the axis of the ion focusing tube so that all ions of the same mass which pass through that plane at the same time impinge on those portions of the cathode surface closest to and farthest from the dynode causing electrons secondarily emitted therefrom to impinge upon the dynode at substantially the same time. This shortens the duration of the mass spectrum signals making it easier to distinguish one mass-spectrum line from another in the 200 to 500 amu range. (auth)

38567 GENERAL ADC/COMPUTER INTERFACE. Moyer, W. R.; Tatarczuk, J. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Instrum. Methods; 102: No. 1, 141-8(1972).

An interface between a 4096 channel nuclear pulse analogue to digital converter and a PDP-7 computer is described. The ADC can be used on-line with the computer, and, when the computer is being used for other purposes, the ADC can be used with two hard-wired 1024 channel memories. This latter use allows experiments to be set up without requiring computer time and permits experiments to be carried out off-line that require only 2048 channels of memory or less. Routing and coincidence circuitry is also provided. The memories of outdated hard-wired analyzers can thus be utilized with up-to-date ADC front ends. (auth)

38568 ION OPTICS AND PERFORMANCE OF A DOUBLE FOCUSING 270° MAGNETIC ANALYZER. Basargin, Yu. G. (Scientific Research Inst. of Electrophysical Apparatus, Leningrad); Boldin, N. I.; Korolev, L. E.; (and others). Nucl. Instrum. Methods; 102: No. 1, 125-9(1972).

For the purpose of testing the characteristics of the 270° analyzer with double focusing suggested earlier the sector magnet has been constructed. The latter has been tested by using a standard α-source. The magnet radius is 60 cm, the field index n = 0.832, the source and the detector are placed at a distance of 100 cm from the sector boundaries. The instrument dispersion corresponds to 70 mm by 1% of momentum changing. The real momentum resolution is 4.5×10^{-4} at a solid angle of 1.4 msterad and the source size 2×10 mm^2. (auth)

38569 INFLUENCE OF TRANSIT TIME DIFFERENCES ON PHOTOMULTIPLIER TIME RESOLUTION. de la Barre, F. (RTC, Suresnes, France). Nucl. Instrum. Methods; 102: No. 1, 77-86(1972).

The influence of transit time differences and the non-uniformity of photocathode yield and collection efficiency of the optical input system on photomultiplier time resolution are investigated. Measurements of the time resolution in function of the photocathode area were performed for three photomultipliers of types XP 1230, PM 2106 and 8575. (auth)

38570 USE OF AN ELECTROSTATIC PARTICLE GUIDE FOR TIME-OF-FLIGHT SPECTROSCOPY OF LOW ENERGY IONS. Abbe, J. C.; Amiel, S.; MacFarlane, R. D. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Instrum. Methods; 102: No. 1, 73-6(1972).

It is shown that the electrostatic particle guide technique can be utilized in time-of-flight measurements of low-energy ions to establish long flight paths without severe loss of intensity. The system was tested using ions from an electron impact ion source which simulated the properties of recoils from decay processes such as β-delayed neutron emission. Transmission efficiencies of up to 30% have been observed for recoil energies ranging from 500 to 3000 eV, corresponding to enhancements of up to 5000 for a 1 m flight path. (auth)

38571 CONSTRUCTION OF A PRESSURE GAGE FOR PuF_6. Tsujimura, Shigeo; Hirano, Kenmei; Takahashi, Akira; Fujisawa, Ginji (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 5, 210-13(May 1972). (In Japanese).

A precise pressure gage for the measurement of the pressure of PuF_6 was developed. The pressure is transmitted through bellows, and the movement produced is measured by a differential transformer. The bellows and other parts of the gage exposed to PuF_6 are made of monel. A cooling fin is provided between the bellows and the differential transformer to make it possible to carry out baking and fluorination at 300°C. The output voltages per unit pressure difference were 2.10 and 2.43 mV/mmHg at room temperature and 300°C, respectively. The gage was used for the study of the transfer efficiency and thermal decomposition of PuF_6, and it proved capable of providing long service without trouble. (5 figures, 2 tables) (auth)

38572 ELECTROSTATIC POTENTIAL IN A TOROIDAL CONDENSER. Wollnik, H.; Matsuo, T.; Matsuda, H. (Osaka Univ.). Nucl. Instrum. Methods; 102: No. 1, 13-17(1972).

The electrostatic potential in a toroidal condenser is derived in the vicinity of a circular main path. The potential is calculated through sixth order for deviations of x and y from this main path. The precision is sufficient to obtain the ion optical properties of a toroidal condenser up to third order image aberrations. A method for designing electrodes to produce any suitable electric field is also presented. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

38573 (ORNL-IIC–12(Suppl.)) SPECIAL SOURCES OF INFORMATION ON ISOTOPES. McKinney, F. E. Baker, P. S. (comps.) (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 61p. Dep. NTIS.

The bibliography contains approximately 300 references. The index lists authors, report numbers, and titles. (J.R.D.)

Isotope Separation (Industrial)

Refer also to abstracts 38223 and 38337.

38574 (K-OA–2032(Rev.1)) EVALUATION OF THE COMPRESSIBLE GAS VORTEX FOR SEPARATION OF URANIUM ISOTOPES. Adams, J. B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 17 Mar 1972. Contract W-7405-eng-26. 20p. Dep. NTIS.

A model for uranium isotope separation in a vortex was investigated. Calculations have been made to evaluate the effect of some operating variables on separative work output. The separation expected at the most feasible operating conditions indicates from 100 to 1000 tubes/kg USW/year would be needed. Capital requirements for a vortex plant would therefore be expected to far exceed the ~\$100 to 140/kg USW/year estimated to be required to build a gaseous diffusion, gas centrifuge, or jet diffusion plant. Power usage for a vortex tube could not be evaluated directly because of lack of data and wide variation in frictional losses to be expected at various operating conditions. However, the inherently high friction loss in a vortex indicates compression ratios of 20 to 100 or more might be needed for staging compared with less than a 10 to 1 pressure ratio for gaseous diffusion and jet processes. Results of a previous evaluation of the gas helix of Creutz indicated its relative power costs to be a factor of 100 greater than that for gaseous diffusion. There is a strong indication that power costs will also prove excessive. Gas velocities in a vortex tube are limited to considerably less than Mach 1 (90 m/sec for UF$_6$). In a gas centrifuge, however, a gas velocity of Mach 4 is readily available with relatively little friction loss. Longer centrifuge bowls as well as higher peripheral velocities appear to be feasible, depending on materials of construction used for the bowl. Therefore, the separation potential of a gas centrifuge appears to be orders of magnitude greater than that of the vortex, and a vortex process cannot compete economically with a modern centrifuge. It appears that any vortex device conceivable that operates in the pressure diffusion range at less than Mach 1 cannot become competitive with the gas centrifuge. Becker's jet appears to be the ultimate in a vortex device, velocities greater than Mach 1 (for UF$_6$) being available because of the use of a large addition of a light carrier gas. However, it may not achieve its separation effect by a simple pressure diffusion process since the transit time through the separation region is near the microsecond range. Other high speed aerodynamic processes similar to Becker's jet or the Fenn shock separation process, which are presumably not limited by pressure diffusion, may be discovered by future research in this area. It is conceivable that processes of this type may be found that are equal to or more effective than Becker's jet diffusion process. The calculated separations for a vortex tube are probably optimistic since the simplifying assumptions concerning attainment of equilibrium, flow decay with tube length, and effect of radial flow on the isotopic gradient were chosen to increase separative work output as compared with a practical case. Factors not included that might increase the separation effect are the gain due to the mixing of a light gas with the process gas (as Mürtz and Nöller found) and a possible gain that might arise from operating the vortex in a countercurrent manner. (auth)

38575 (K-OA–2103) REVIEW OF THE PERFORMANCE OF SEPARATION CASCADES AND THE BEHAVIOR OF THE MINOR URANIUM ISOTOPES. Blumkin, S.; Von Halle, E. (Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.). 24 Mar 1972. Contract W-7405-eng-26. 48p. Dep. NTIS.

It has been determined that the concentrations of the minor uranium isotopes relative to that of ^{235}U in enrichment cascade streams vary in a characteristic way with the cascade flowsheet. Measurement of the isotopic concentrations of ^{234}U, ^{235}U, and of ^{236}U, if present, in cascade streams in conjunction with stream rate measurements can be used to corroborate or contradict the validity of material accountability results and in addition assist in determining the possible nature of a diversion when an operation is suspect. The necessity to measure the cascade feed and withdrawal rates as accurately as possible is not obviated by the application of minor isotope safeguard technique (MIST), since any consistent bias or misrepresentation in such measurements cannot be uncovered by MIST. The effectiveness with which MIST might be applied is dependent on the analytic precision with which the minor isotopes can be determined and the range in which steady-state cascade data normally fluctuate. These matters, and some others which are mentioned, will require investigation before any final conclusion on the usefulness of MIST can be made. (auth)

38576 (LIB/Trans–411) SEPARATION COSTS OF ^{235}U-ENRICHMENT IN INDUSTRIAL SEPARATION NOZZLE CASCADES. Schuette, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). Translated by A. Bicevskis (Australian Atomic Energy Commission), from report KFK–1431. 15p. Dep. NTIS (U. S. Sales Only).

An abstract of this report prepared from the original appeared as NSA. 26: 15369. (Australia)

38577 (LIB/Trans–417) PHYSICAL PRINCIPLES UNDERLYING ^{235}U ENRICHMENT BY THE SEPARATION NOZZLE PROCESS: THE EFFECT OF THE ADDITION OF A LIGHT GAS. Becker, E. W.; Bier, W.; Ehrfeld, W.; Eisenbeiss, G. Translated by U. Engelbert (Australian Atomic Energy Commission), from Z. Naturforsch.; 26a: No. 9, 1377-84(1971). 15p. Dep. NTIS (U. S. Sales Only).

An abstract of this article prepared from the original appeared as NSA. 26: 9157. (Australia)

38578 DEVICE FOR SEGMENTING GASEOUS OR VAPOROUS SUBSTANCES, ESPECIALLY ISOTOPES, WITH DIFFERENT MOLECULAR WEIGHTS AND/OR DIFFERENT GAS KINETIC CROSS SECTIONS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,272,989. 3 May 1972. Priority date 30 Sep 1968, Germany.

An apparatus is described for separating binary mixtures of vapors having different molecular weights and/or different gas-kinetic cross sections. A gas mixture is supplied to nozzles which have flow re-directing walls. The nozzles effect separation of the gas mixtures into heavy and light fractions. A stripping screen directs the fractions to pipes or chambers. (J.R.D.)

38579 BUENOS AIRES ISOTOPE SEPARATOR ON-LINE FACILITY (IALE PROJECT). Achterberg, E.; Iglesias, F. C.; Jech, A. E.; (and others) (Comision Nacional de Energia Atomica, Buenos Aires). Nucl. Instrum. Methods; 101: No. 3, 555-62(1972).

The isotope separator on-line facility operating at Buenos Aires (IALE Project) is described. It has been successfully used in nuclear spectroscopic studies of fission products of ^{235}U. (auth)

38580 CHEMICAL PURIFICATION AND TREATMENT OF CADMIUM ISOTOPES SEPARATED BY THE ELECTROMAGNETIC WAY. Kellner, K. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Leipzig). Isotopenpraxis; 8: No. 1, 22-5(Jan 1972). (In German).

The chemical purification of cadmium isotopes gathered in the target pockets of an electromagnetic isotope separator from a series of foreign elements is described. Furthermore, chemical treatment of samples for mass-spectrometric isotope analysis purpose and preparation of metallic cadmium isotopes is indicated. (auth)

Isotopic Power Sources

Refer also to abstracts 38361 and 38824.

38581 (CONF-720519–1) ^{244}Cm: A RADIOISOTOPIC POWER FUEL. McHenry, R. E. (Oak Ridge National Lab., Tenn.). 1972. 17p. Dep. NTIS.

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972).

The alpha-emitting radioisotope curium-244 is being developed by the USAEC as a power source for any of several conversion systems which produce electrical power. Projected costs and availability make this radioisotope especially promising. The cost of curium-244 which is produced in nuclear power reactors is estimated at \$60/Watt (thermal) in quantities of 95 kW (thermal) per year by 1980. The efficient and safe use of this isotopic fuel requires that a suitable compound be prepared and fabricated into a suitable form with fully characterized physical and chemical properties. The task elements for accomplishing this program consist of compound preparation, source fabrication, compound characterization, source design, and prototype testing. Techniques developed for accomplishing these tasks and the results achieved to date are reviewed. (auth)

38582 (HIT-3627-15) ADVANCED LARGE MILLIWATT RADIOISOTOPE GENERATOR STUDY PROGRAM. Final Report. (Hittman Associates, Inc., Baltimore, Md.). 31 May 1966. Contract AT(30-1)-3627. 288p. Dep. NTIS.

Declassified 2 Nov 1971.

Results of parametric studies to determine the general characteristics of various advanced large milliwatt thermoelectric generator systems are presented. Information gathered in a market survey is included along with results of a design study. (J.R.D.)

38583 (LA-DC-72-473) CHARACTERIZATION AND PROPERTIES OF MEDICAL-GRADE ^{238}Pu FUELS. Mullins, L. J.; Matlack, G. M.; Bubernak, J.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). 1972. 19p. (CONF-720519-2). Dep. NTIS.

From second international symposium on power from radioisotopes; Madrid, Spain (29 May 1972).

The ^{238}Pu requirements, 55 to 90g, for an artificial heart or circulatory assist device demand a fuel having minimal radiation properties. The preparation and evaluation of potential ^{238}Pu fuel forms at the Los Alamos Scientific Laboratory has led to the development of four fuel compositions, electrorefined metal, ^{238}Pu-3 at. % Ga, ^{238}Pu^{15}N, and ^{238}Pu^{16}O$_2$. (The latter three fuels are made from electrorefined metal.) Theoretical and experimental studies of these fuels led to the conclusion that ^{238}Pu^{16}O$_2$ is the preferred composition for high temperature application in the artificial heart program. This fuel is prepared as a pressed and sintered oxide. Procedures have been developed for preparing and characterizing cylindrical oxide sources varying in size from one to fifty watts. (auth)

38584 (MDC-G-3142) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 14, January-March 1972. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Apr 1972. Contract AT(45-1)-2138. 47p. Dep. NTIS.

Compatibility tests in support of the Multi-Hundred Watt Radioisotope Thermoelectric Generator (MHW-RTG) clearly demonstrate that Mo/Ir and Mo/HfO$_2$ are unsatisfactory and unnecessary as barriers between plutonia and iridium. Results of isothermal tests conducted for the Multi-Hundred Watt Thermoelectric Generator Program at 1500°C for 1000 and 5000 hours indicate that a system containing almost stoichiometric (PuO$_{1.98}$) plutonia/iridium/graphite would be compatible. Preparations were initiated on further MHW-RTG testing using a more systems-oriented configuration, a thermal gradient, and micro-size iridium tensile specimens. In the base-line compatibility testing program it has been found that both plutonia-238 and curia-244 migrate at 1800°C and long-term exposure (12,000 to 18,000 hours) resulting in radioisotope deposition on the colder metallic surfaces. Both Mo-46Re and W-30Mo-30Re were excellent containers for curia-244 at temperatures to 1800°C for 12,000 hours, and Mo-46Re retained its capability to 2000°C for 10,000 hours. Other container materials such as W-25Re, Mo, and Re are adequate, but inferior. Neither Mo-46Re nor Ta-10W prevent oxygen transport from plutonia-molybdenum cermet (PMC) fuel to a T-111 structural alloy at 1500°C. Other materials combinations are currently being examined. Plutonia and PMC fuel aging specimens with curium-242 additions to accelerate helium generation continue exposure at 850 and 1200°C. (auth)

38585 (MLM-1887) MOUND LABORATORY ISOTOPIC POWER FUELS PROGRAMS: OCTOBER-DECEMBER 1971. (Mound Lab., Miamisburg, Ohio). 24 Mar 1972. Contract AT(33-1)-Gen-53. 25p. Dep. NTIS.

Research and development progress is reported on pressed PuO$_2$ fuel spheres for the multihundred watt program, coating of PuO$_2$-Mo cermet fuels, analysis of PuO$_2$-Mo cermet fuels, and compatibility testing of PuO$_2$ with Mo-Re fuel capsules at 800 to 1000°C. (J.R.D.)

38586 (WAI-TR-70.6-AEC) REVIEW AND EVALUATION OF TRW SAFETY ANALYSIS REPORT, VOLUMES I AND II FOR THE PIONEER RADIOISOTOPE HEATER UNIT. (Weiner Associates, Inc., Baltimore, Md.). Dec 1970. 19p. Dep. NTIS.

A review of the TRW Safety Analysis Report, Volumes I and II was conducted to determine if all potential accident situations are adequately satisfied and to evaluate the radiological consequences of all potential environments. As such, this represents the judgment of Weiner Associates, Inc., on the aerospace nuclear safety of the radioisotope heater unit (RHU). TRW states that all prelaunch accidents, such as handling and shipping, can be eliminated from consideration since their environments are less severe than ascent and launch environments (although air transport was not considered for Transit). Therefore, they were not analyzed. Based on the experience of the Transit TRG, this assumption is reasonable. The key safety problems are associated with the launch pad and ascent aborts. A summary (WAI's review) of launch pad and ascent environments and how they were analyzed by TRW is presented. It is stated in Volume I that under certain unlikely conditions, fuel may be released from the RHU's as a result of a launch pad abort. (auth)

Radiation Sources

Refer also to abstracts 38360, 38363, 38398, 38852, 38909, 38911, 39004, 39005, and 40061.

38587 USE OF RADIOISOTOPES IN PLASTIC MATERIAL TESTING. Rotrekl, B. (Vyzkumny Ustav Syntetickych Pryskyric a Laku, Pardubice, Czech.). Radioisotopy; 13: No. 1, 55-73(1972). (In Czech).

Testing of plastics and paints to measure aging and degradation processes is a new field of radioisotope applications. The quality of the protective properties of paints and of the insulating properties of plastics can be judged from the diffusion rate of various labeled liquids, especially of tritiated water. The process of aging and degradation of plastics and paint binders is considerably influenced by their chemical and physical heterogeneity and internal stress. Their investigation by conventional methods is difficult and inaccurate. Radiotracer methods are described which can be used to obtain the required information and to investigate the kinetics of these processes. Radiotracer methods are also useful for wear studies of plastics and paints, especially for accurate and quick determination of abrasive wear. (auth)

38588 DEVELOPMENTS IN USE OF ^{252}Cf FOR NEUTRON RADIOGRAPHY. Barton, John P. (Argonne National Lab., Ill.). Nucl. Technol.; 15: No. 3, 56-67(Jul 1972).

Studies were performed to evaluate the isotopic neutron source ^{252}Cf for neutron radiography. By special methods of fine tuning it is possible to obtain neutron radiographs that can be compared with those obtained from a nuclear reactor facility using very low collimation (gadolinium foil converter, medium resolution film, 1 : 25 collimator ratio). The ^{252}Cf exposure necessary for this quality neutron radiograph is 1 mg for 100 hours (or 10 mg for 10 hours etc.). ^{244}Cm-Be, a neutron source expected to become available as a by-product of the nuclear power program, provides neutron radiographs similar in quality to those from ^{252}Cf. (auth)

Design and Fabrication

Refer also to abstract 38509.

Industrial Uses

38589 ORGANOLEPTIC PROPERTIES OF γ IRRADIATED PAPAYAS. Moy, J. H.; Ross, E.; Hsia, S. T.; Sawato, M. (Univ. of Hawaii, Honolulu). Food Irradiat.; 11: No. 4, 12-18 (Jul-Dec 1971). (In French).

The organoleptic qualities of fumigated or irradiated Hawaiian Solo papayas were studied during the preliminary expeditions undertaken to evaluate the effects of transport by boat (September 1967) and aircraft (March 1968). The purpose of the studies was to determine if the qualities of the fruit had or had not varied subsequent to the γ irradiations and handling involved. The results of a jury of tasters and various objective evaluations demonstrate that irradiated or fumigated fruit have comparable properties. Irradiated papayas, however, develop a particular flower-like smell after a long boat voyage. It was observed that irradiated papayas sent by aircraft were firmer than fumigated samples (after 4 days). The phenomenon connected with the flower-like odor is not known. The firmer texture is known to be the result of delayed ripening induced by γ irradiation. (France)

38590 STERILIZING OF CATHETERS AND METAL GUIDES USED IN ANGIOGRAPHY. Steinert, R. Tidsskr. Norske Laegeforen.; 92: No. 9, 642-4(30 Mar 1972). (In Norwegian).

Clear instructions on the pretreatment of catheters and metal guides for angiography have been lacking. As a result many hospitals use methods not always acceptable to bacteriologists. There are three methods available, namely chemical liquids, ethylenoxide gas, and ionizing radiation. The first is totally unacceptable giving at best a disinfection. The second is not reliable and takes a long time. Ionizing radiation is the best, and the ^{60}Co irradiation facility at Institutt for Atomenergi (IFA) at Kjeller, Norway, is approved for sterilization of medical equipment which is discarded after use. The dose is based on the number of bacteria inside the packing, where this is not known, 4.7 megarad is used. While groups of micro-organisms may be generally classified by radioresistance, such classification involves many exceptions. Some microorganisms have been found which require up to 6 to 8 megarads, but these do not normally occur on medical equipment. Some imported angio-equipment is purportedly gamma sterilized, but the dose is not given. Investigations on the reuse of catheters after resterilization have been made. Chemical cleaning of used metal guides is described. (auth)

LIFE SCIENCES

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 38616, 38668, and 38678.

38591 (AEC-tr-7306, pp 10-20) DIFFERENCES BETWEEN DNA STRUCTURE AND FUNCTION IN NORMAL AND GAMMA-IRRADIATED ANIMAL CELLS. Strazhevskaya, N. V.; Struchkov, V. A. (Inst. of Biophysics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 5, 649-55 (Sep-Oct 1971).

A gentle method is suggested for the preparative isolation from various animal tissues of two DNA fractions (euchromatin and heterochromatin) which differ in molecular weight and incorporation of ^{3}H-thymidine. The amount of fraction euchromatin varies from tissue to tissue in accordance with its metabolic level: 20% of total nuclear DNA in mouse ascites, 16% in rat thymus, 34% in rat spleen, 50% to 60% in rat liver and brain, but virtually none in nonmetabolizing tissues such as Misgurnus sperm and chicken erythrocytes. The characteristic viscosity of the two fractions was 300 and 412 dl/g, respectively. Experiments on the incorporation of ^{3}H-thymidine into mouse ascitic cells showed that heterochromatin incorporated the label two to three times more rapidly than did euchromatin. Irradiation of rats at 1 kR caused a redistribution of the two DNA fractions in rat thymus 1, 2, and 6 hrs after irradiation. This did not happen in the liver. (tr-auth)

38592 (AEC-tr-7306, pp 21-6) CYTOFLUOROMETRIC ANALYSIS OF EARLY RADIATION CHANGES IN ADRENAL CORTEX DNA AND DNP. Khamidov, D. Kh.; Khakimov, P. A.; Mamataliev, U. (Inst. of Biochemistry, Tashkent). Translated from Radiobiologiya; 11: No. 5, 656-9 (Sep-Oct 1971).

The cytofluorometric method was used to investigate the dynamics of changes in DNA and DNP in the nuclei of adrenocortical cells gamma-irradiated at doses ranging from 50 to 1200 R. The DNA content of the cells was found to increase shortly after exposure to low doses. High doses intensified secondary luminescence and reduced the amount of DNA. A parallel is drawn between the changes in DNA and DNP content and functional activity of the adrenal cortex in response to different doses of radiation. (tr-auth)

38593 (AEC-tr-7306, pp 27-32) SEDIMENTATION ANALYSIS OF BONE-MARROW AND BLOOD DNA IN NORMAL AND IRRADIATED ANIMALS. Kritskii, G. A.; Abidov, A. A.; Aleksandrov, S. V.; Batishchev, A. I.; Ermakov, N. V. (Bakh Inst. of Biochemistry, Moscow). Translated from Radiobiologiya; 11: No. 5, 660-3 (Sep-Oct 1971).

Experiments with x irradiation of rabbits showed that in sedimentation studies, denaturation of DNA and treating it with an alkali to remove admixed RNA permits the detection of latent radiation injury in cases where analysis of native DNA preparations not freed from admixed RNA treated with an alkali fails to reveal any differences in the sedimentation coefficients. It was also shown that an increase in admixed RNA in preparations of native DNA isolated from the whole blood of irradiated animals can serve as a sensitive indicator of the severity of radiation injury. (tr-auth)

38594 (AEC-tr-7306, pp 55-64) CHANGES IN COMPOSITION OF CELLS, PROTEINS, AND ENZYMES OF THORACIC DUCT LYMPH IN RATS DURING ACUTE RADIATION SICKNESS. Polushkina, E. F.; Kashkin, K. P.; Kartasheva, A. L.; Surinov, B. P. (Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 5, 679-85 (Sep-Oct 1971).

Changes in cellular composition, protein spectrum, and antigens as well as the spectrum and activity of nonspecific esterases and alkaline phosphatases of thoracic duct lymph in rats during acute radiation sickness were studied. Irradiation of the animals at 700 R resulted in marked loss of cells in thoracic duct lymph, redistribution of the relative content of protein fractions, appearance of additional tissue and serum antigens, and decreased activity of esterases and alkaline phosphatase. (auth)

38595 (AEC-tr-7306, pp 65-71) EFFECT OF X IRRADIATION ON THE ANTIOXIDANT ACTIVITY OF RAT LIVER LIPIDS. Ryazanov, V. M. (Moscow State Univ.). Translated from Radiobiologiya; 11: No. 5, 686-9 (Sep-Oct 1971).

The effect of x irradiation on the antioxidant activity (AOA) of rat liver lipids and the individual fractions was studied. AOA was determined by the method of inhibition of electrochemiluminescence of the methanol citrate system, while Folch's method and thin-layer chromatography were used to obtain the lipid fractions. The AOA of the total lipids determined normally from their phospholipid (PL) fraction decreased after irradiation owing to the reduced amount in the total lipids of such natural antioxidants as lecithins, cephalins, cerebrosides, and sphingomyelins and decrease in AOA of some of these fractions. It is conjectured that the changes in AOA of the individual PL fractions after irradiation (700 R) are caused by the increased content of phospholipids with unsaturated fatty acids, some of which may be oxidized. (tr-auth)

38596 (COO-1313-34) EFFECTS OF GAMMA-IRRADIATION ON DNA TRANSCRIPTION AND RNA TRANSLATION IN PLANTS. Progress Report and Renewal Proposal. Cherry, Joe H. (Purdue Univ., Lafayette, Ind. Dept. of Horticulture). 1972. Contract AT(11-1)-1313. 9p. Dep. NTIS.

It was shown that γ irradiation of sugar beet tissue inhibits RNA synthesis and subsequent protein synthesis. The species of RNA inhibited was demonstrated by MAK column chromatography to be ribosomal and possibly messenger RNA. In addition, data indicate that exposure of RNA polymerase in vivo or in vitro to irradiation results in an inhibition of RNA synthesis. Since multiple polymerases were shown to exist in eucaryotic cells, the consequences of irradiation might depend on the concentration or activity of the type(s) of RNA present. Therefore, based on the fact that 73% of the total RNA polymerase activity appeared to be RNA polymerase I and the fact that ribosomal RNA synthesis was inhibited, it appears that one of the critical sites involved in radiation damage is the alteration of RNA polymerase I resulting in an inhibition of rRNA synthesis. In addition, however, the data do not preclude the possibility that RNA polymerase II is also inhibited resulting in a reduction or alteration of mRNA which may be a key to radiation damage. It is interesting to note that damaged DNA template although not altered as much as the enzyme based on RNA polymerase assays, may be of just as much consequence to the cell. The RNA transcribed from damaged template may result in altered proteins, mutations (if damage remains nonrepairable) and perhaps cell death. (auth)

38597 (COO-3095-1) ULTRAVIOLET LIGHT EFFECTS ON NUCLEIC ACID FORMATION AND GENETIC EVENTS IN BACTERIA. Annual Progress Report. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia, Pa. Dept. of Genetics). Apr 1972. Contract AT(11-1)-3095. 7p. Dep. NTIS.

This investigation deals with the effect of ultraviolet light on the nucleic acids of bacterial cells. Exposure to uv prevents DNA replication and also interferes with RNA formation. The program is devoted to studies of the cellulary recovery mechanism that results in resumption of normal macromolecular synthesis after uv exposure and the mistakes made in the process of these repair mechanisms that lead to mutation. It includes study of the induction of non-photoreversible damage blocking normal semiconservative DNA replication and presumably leading to a requirement for postirradiation RNA protein formation in restoration of new origin for DNA replication. It investigates the non-recoverable but photoreversible damage inactivating DNA replication and its relation to cell lethality. It attempts to explore the nature of the mutation induction process and determine its possible relation to the non-conservative DNA replication involved in excision repair, to recombination processes, and to repair mechanisms dependent on the initiation of semiconservative DNA replication after radiation damage. (auth)

38598 SENSITIVITY OF MONOMERIC AND DIMERIC FORMS OF ESCHERICHIA COLI THYMIDINE KINASE TO ULTRAVIOLET RADIATION. Cysyk, R. L.; Prusoff, W. H. (Yale Univ., New Haven). Photochem. Photobiol.; 15: No. 6, 589-93 (Jun 1972).

Ultraviolet irradiation (from 0 to 20 Ergs mm^{-2} × 10^3) of Escherichia coli thymidine kinase in the absence or presence of the regulatory nucleotides deoxycytidine diphosphate (d CDP, an activator) or deoxythymidine triphosphate (dTTP, an inhibitor) resulted in an exponential loss of catalytic activity. However, concentrations of the regulators that result in dimerization significantly reduced the rate of inactivation. There was correlation between the effect of regulator concentration on the extent of protection, and on the extent of activation or inhibition. Results are presented for concentrations of d TTp from 0 to 0.2mM and for dCDP from 0 to 0.4mM. (UK)

38599 X-RAY INACTIVATION OF LACTATE DEHYDROGENASE IN DILUTE SOLUTION. Schuessler, H.; Denkl, P. (Univ., Erlangen, Ger.). Int J. Radiat. Biol.; 21: No. 5, 435-43 (May 1972).

X-irradiation (over a dose range 0 to 240 Krads) of dilute solutions of LDH$_5$ (lactate dehydrogenase) in phosphate buffer induced simultaneously with the loss of activity several changes of the protein structure which became obvious by measuring the u.v.-absorption spectrum, the amino-acid composition, and the titrable SH-groups. The conformational changes caused the occurrence of four components different in molecular size which could be separated by gel-filtration. The results are compared with those obtained in similar experiments with ribonuclease. (UK)

38600 STUDIES ON THE SUBSTRATE SPECIFICITY OF THE T$_4$ EXCISION REPAIR ENDONUCLEASE. Friedberg, Errol C. (Stanford Univ., Calif.). Contract AT(04-3)-326. Mutat. Res.; 15: No. 2, 113-23(Jun 1972).

Previous studies have shown that the ν gene of bacteriophage T4 codes for an endonuclease that specifically attacks pyrimidine dimer sites in uv-irradiated DNA. The present studies have examined the role of this endonuclease in the repair of DNA damaged by nitrogen mustard, N-methyl-N′-nitro-N-nitrosoguanidine (NTG), mitomycin C and 4-nitroquinoline-N-oxide. The observation by Harm that the ν gene product of phage T4 facilitates repair of uv damage to the host DNA of excision-repair defective strains enabled us to test whether it does the same with other cellular DNA lesions. It was shown that infection of uv-irradiated E. coli B$_{s-1}$ with uv-inactivated phage T4ν+ resulted in rescue of a certain fraction of the host cells. However no ν gene mediated repair of E. coli B$_{s-1}$ was observed following treatment with the chemical agents mentioned. Furthermore, though phage T4ν_1 is more sensitive to uv-irradiation than phage T4, there was no observed difference in the sensitivity of these phages to nitrogen mustard or NTG. On the basis of these observations it was concluded that the ν gene coded endonuclease of T4 is specific for the excision repair of pyrimidine dimers and does not participate in the repair of chemically damaged DNA. In vitro enzymatic degradation of DNA alkylated with nitrogen mustard was observed, but it is probable that this degradation is not part of a repair reaction in vivo. (auth)

38601 INVESTIGATIONS OF CHANGES IN THE SOLUBLE PROTEINS FROM CHICKEN MEAT AFTER IONIZING IRRADIATION. Klein, W.; Altmann, H. (Reaktorzentrum, Seibersdorf, Austria). Kerntechnik; 14: No. 3, 135-8(Mar 1972). (In German and English).

Soluble proteins from gamma-irradiated and from non-irradiated chicken meat (breast and leg) were separated by disc electrophoresis, and the changes in the individual protein fractions caused by irradiation up to various absorbed-dose levels were studied. Market effects were found only after irradiation at doses of the order of those required for sterilization. (auth)

38602 RADIATION LESIONS OF THE RENATURATION CAPACITY OF DNA, CAUSED BY THE ACTION OF PROTONS, HEAVY IONS, AND GAMMA-RAYS. Marinova, C. I.; Petrova, S. N.; Govorun, R. D.; (and others). Rentgenol. Radiol.; 10: No. 1, 1-7(1971). (In Russian).

With the purpose of establishing the radiation dose affecting the possibilities of single-chain DNA for complementary union, the renaturation capacity of DNA denatured by heat was studied after irradiation with protons, heavy ions, and gamma rays. In irradiation with protons at a dose of 50 kilorads, the renaturation capacity of DNA was affected in 63%, at 60 kilorads, 34% and at 80 kilorads, 98%. A non-specific renaturation was obtained with doses over 100 kilorads. The lesion effect was considerably less (33% at a dose of 50 kilorads and 83% at 80 kilorads). By irradiation of DNA, in dry condition, no lesion was obtained at 50 and 60 kilorads, while at 80 kilorads it was 45%. Following irradiation with γ rays, the injuring doses were considerably higher, from the order of 200 kilorads, and the injury, 30% (at 196 and 216 kilorads), and 53% (at 255 kilorads). Following irradiation of DNA (dry condition with heavy ions at a dose of 50 kilorads, the injury was 30%, at 60 kilorads, 57%, and at 80 kilorads, 78%. A conclusion is made that the initial effect of the radiation lesion, the disruption of DNA at the phosphoric-ester links, does not affect the renaturation capacity of DNA. The considerable doses, bringing about the destruction of the nucleic bases, lead to an impossibility for complementary union of the DNA chains. (Abstr. Bulg. Med. Sci. Lit.)

38603 CHANGES IN TOTAL DIFFUSE SPECTRAL REFLECTANCE OF AMINO ACIDS AND PROTEINS AFTER ULTRAVIOLET IRRADIATION. Anglin, J. H. Jr.; Sayre, R. M.; Batten, W. H. (Oklahoma Health Science Center, Oklahoma City). Photochem. Photobiol.; 15: No. 6, 537-54(Jun 1972).

Total diffuse reflectance spectra of air-dried surfaces of free and neutralized amino acid preparations before and after irradiation in vitro are reported. It was found that some free or neutralized amino acid surfaces underwent modification which resulted in changes in the diffuse reflectance spectra after u.v. exposure. It is suggested that these reflectance changes result from transformations in the side chains of the amino acids and that the transformations may differ from those occurring when amino acids in solution are irradiated. Histidine, cystine, hydroxyproline and some protein surfaces showed changes in reflectance of 330 to 400 nm light similar to those reported in skin after u.v. irradiation in vivo. (UK)

38604 EXCISION OF PYRIMIDINE DIMERS FROM DNA OF ULTRAVIOLET IRRADIATED YEAST. Unrau, P.; Wheatcroft, R.; Cox, B. S. (Botany School, Oxford). Mol. Gen. Genet.; 354: No. 4, 359-62(1971).

Pyrimidine dimers formed by ultraviolet light in the DNA of haploid Saccharomyces cerevisiae were removed under the influence of photoreactivating light and also in the dark under growth conditions. The integrity of the rad 1 locus is necessary for the dark-removal of dimers. (auth)

Radiation Effects on Cells (External Source)

Refer also to abstracts 38668 and 38695.

38605 (AEC-tr—7306, pp 1-9) CURRENT THEORIES IN RADIOBIOLOGY. Kuzin, A. M. (Inst. of Biophysics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 5, 643-8(Sep-Oct 1971).

Historical survey of the theories in radiobiology elaborated during the past 10 yrs is presented. The dissatisfaction of some investigators with the formal concepts of target theory is emphasized. A summary of the main principles of the structural-metabolic theory in radiobiology based on an analysis of modern physicochemical studies on the irradiated cell is given. (tr-auth)

38606 (AEC-tr—7306, pp 33-9) DNA METABOLISM IN ROOTS OF IRRADIATED PEA SPROUTS DURING RECOVERY FROM RADIATION. Golikova, O. P.; Grodzinskii, D. M. (Inst. of Plant Physiology, Kiev). Translated from Radiobiologiya; 11: No. 5, 664-8(Sep-Oct 1971).

Various DNA precursors (2-^{14}C-thymine, 2-^{14}C-thymidine, and ^{32}P-orthophosphate) were used to study the biosynthesis of DNA in segments of roots from two-day-old pea sprouts after irradiation. A comparison of the dynamics of the specific DNA activities during the period under study with the curves of the relative growth rates of the irradiated root segments indicated that the meristematic cells lost their capacity for division during the first few hours after irradiation. The enzymic systems associated with the conversion of thymine and thymidine were inhibited at this time. These changes are eventually reversed. (tr-auth)

38607 (AEC-tr—7306, pp 72-80) USEFULNESS OF THE ANAPHASE AND METAPHASE METHODS OF RECORDING THE RADIOSENSITIVITY OF CHROMOSOMES IN IN VIVO AND IN VITRO EXPERIMENTS. Morozova, L. M.; Kondrina, L. P.; Osetrova, T. D. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Translated from Radiobiologiya; 11: No. 5, 690-5(Sep-Oct 1971).

The anaphase and metaphase methods of recording spontaneous and radiation-induced (dose 50 R) chromosome mutations in bone marrow cells and mouse (C57BL) embryonal fibroblasts were evaluated. Study of spontaneous mutations of chromosomes by the anaphase and metaphase methods failed to reveal any quantitative differences between them. Radiation-induced chromosomal mutations were detected by the metaphase method 3.5 times more often in embryonal fibroblasts in vitro and 2.5 times more often in bone marrow cells. The reasons for the differences in resolving power of these methods are discussed. (tr-auth)

38608 (AEC-tr—7306, pp 97-109) INTENSIFICATION OF THE EFFECT OF IRRADIATION BY ARTIFICIAL STIMULATION OF CELL METABOLISM. II. Kalendo, G. S.; Yarmonenko, S. P.; Nikolaeva, T. G.; Komarova, L. E.; Vinskaya, N. P. (Inst. of Experimental and Clinical Oncology, Moscow). Translated from Radiobiologiya; 11: No. 5, 706-11(Sep-Oct 1971).

Brief treatment of HeLa cells with leukocytes at a concentration of 0.5 μg/ml resulted in an increased number of cells in the S stage and intensified DNA synthesis. There was an increase in the rate of passage through the G$_2$ stage and in the yield of cells from the radiation block G$_2$-M due to irradiation at 150 R. Leukocytin treatment of the formed monolayer of cells 5 to 30 min before or immediately after irradiation lowered the level of endogenous thiols and intensified the radiation lesions. This effect did not occur when the cells were treated in the lag phase of growth. The introduction of leukocytin 30 min before or immediately after local irradiation of transplantable rat tumors (Pliss lymphosarcoma and M-1 sarcoma) helped to inhibit their growth and in some cases resulted in their resorption. (tr-auth)

38609 (AEC-tr-7306, pp 110-17) CHANGES IN THE PROPERTIES OF IRRADIATED THYMOCYTE NUCLEAR MEMBRANES REVEALED BY THE OSMOTIC SHOCK METHOD. Kuzin, A. M.; Le Dak Lieu (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 5, 713-17(Sep-Oct 1971).

The osmotic shock method was used to investigate the properties of thymocyte nuclear membranes after x irradiation of the animals and isolated nuclei. Even irradiation at 200 rad was found to induce significant changes in the osmotic properties of the membranes both in vitro and in vivo. These changes could be detected only when metabolism in the nuclei was normal (37°, presence of O_2 or glucose in the medium) after irradiation. (tr-auth)

38610 (AEC-tr-7306, pp 125-30) EFFECT OF RADIATION ON THE PERMEABILITY OF A MULTICELLULAR MESENTERIC MEMBRANE. Le Dak Lieu; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 5, 723-6(Sep-Oct 1971).

The effect of x rays on the permeability to two coenzymes, $NADH_2$ and cocarboxylase, of a multicellular membrane of guinea pig mesentery after irradiation at doses ranging from 1 to 20 kR was studied. The mesentery was radioresistant and its permeability to these substances increased only after exposure to 5 kR or more. Its radiosensitivity scarcely changed after treatment with 5% dodecylsulfate. (tr-auth)

38611 (AEC-tr-7306, pp 196-201) EFFECT OF RADIATION ON THE INTERACTION OF MOUSE SPLEEN CELLS IN MIXED CULTURE IN VITRO. Mikhaylova, Z. Z.; Galkina, N. S. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 771-4(Sep-Oct 1971).

The radioisotopic method was used together with an immunosorbent to study the intensity of gamma globulin synthesis in individual and mixed cultures of intact and irradiated mouse spleen cells. The combined cultivation of irradiated spleen cells or irradiation of one of the populations of the mixed culture was found to inhibit gamma globulin synthesis more than did separate cultivation of the corresponding irradiated and nonirradiated cells. The degree of inhibition of gamma globulin synthesis was the same in both allogeneic and syngeneic mixtures. (tr-auth)

38612 EQUATION FOR PREDICTING THE SURVIVING FRACTION OF CELLS IRRADIATED WITH SINGLE PULSES DELIVERED AT ULTRA-HIGH DOSE RATES. Weiss, Herbert (Sloan-Kettering Inst. for Cancer Research, New York). Radiat. Res.; 50: No. 2, 441-52(May 1972).

An equation has been derived that predicts surviving fraction when cells which have been equilibrated with oxygen are exposed to high intensity single pulses of radiation. The equation allows for the quantitative examination of various features of pulse irradiated survival curves. It is found that the spacing between anoxic segments of the survival curves is not a linear function of initial oxygen concentration. A function is added to the equation thereby permitting a fit of the derived equation to experimentally determined survival curves where a shoulder is involved. Fitting the equation to experimental data provides a means for determining the dose required to deplete oxygen in the cells and for determining the constant K in the equation that relates radiosensitivity to oxygen concentration. As a result of the derivation, an experiment at conventional dose rates is suggested. (auth)

38613 CAFFEINE-SENSITIVE REPAIR OF ULTRAVIOLET LIGHT-DAMAGED DNA OF MOUSE L CELLS. Fujiwara, Yoshisada; Kondo, Teruo (Kobe Univ., Japan). Biochem. Biophys. Res. Commun.; 47: No. 3, 557-64(12 May 1972).

Mouse L5 cells, although as resistant to uv as excision-capable HeLa S3 cells, do not excise thymine dimers yielded at a rate of 0.05% thymine per 100 ergs/mm^2. The daughter DNA newly replicated for 2 hours in 200 ergs/mm^2-irradiated L5 cells is discontinuous with gaps spaced at about 5×10^6 daltons and seemingly complementary to photoproduct on the parental strand. The gapped DNA is subsequently sealed by the postreplication repair. Caffeine (2mM) inhibits such a DNA repair in irradiated L5 cells, but not in HeLa S3 cells. This result is correlated with caffeine-effected depression of recovery in the colony-forming ability of L5 cells after irradiation. (auth)

38614 ULTRAVIOLET AND GAMMA-RAY INDUCED REPRODUCTIVE DEATH AND PHOTOREACTIVATION IN A XENOPUS TISSUE CULTURE CELL LINE. Griggs, H. G.; Bender, M. A. (Vanderbilt Univ., Nasvhille). Photochem. Photobiol.; 15: No. 6, 517-26(Jun 1972).

A clone having a plating efficiency of about 60 to 70% was isolated from the A8 Xenopus laevis tissue culture cell line. It was used to test for photoreactivation of ultraviolet induced loss of colony-forming ability, together with a Chinese hamster cell line. Photoreactivation of the Xenopus cell line produced a dramatic increase in survival. Time and temperature dependence experiments suggested that this was a true enzymatic process. Photoreactivation affected the extrapolation number of the survival curves, rather than their slope. The cells lacked a caffein-sensitive dark repair mechanism and photoreactivation is caffein-independent. Parallel gamma-ray experiments showed no photoreactivation, and cells were remarkably resistant to gamma-ray killing, in marked contrast to their ultraviolet sensitivity. Ultraviolet irradiation was carried out over a dose range 0 to 350 ergs/mm^2, and γ radiation over a dose range 0 to 1700 rads. (UK)

38615 RADIOSENSITIZATION OF MAMMALIAN CELLS BY p-NITROACETOPHENONE. II. EFFECTIVENESS OF ANALOGUES. Chapman, J. D.; Raleigh, J. A.; Borsa, J.; Webb, R. G.; Whitehouse, R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Int. J. Radiat. Biol.; 21: No. 5, 475-82(May 1972).

Analogues of p-nitroacetophenone (PNAP) were tested on Chinese-hamster cells for their ability to inhibit cell proliferation (measure of toxicity) and to sensitize hypoxic cells to x rays. Compounds with different substituents at the para position on the benzene ring showed capabilities of interfering with cell proliferation which could be correlated with their electronegativities. Using the 50% "inhibition of proliferation" value as an estimate of toxicity, the analogues showed decreasing toxicity in the order $p\text{-}NO_2 > p\text{-}Cl, p\text{-}Br > p\text{-}OCH_3 > p\text{-}CH_3 > p\text{-}NH_2 >$ acetophenone. Of these compounds only PNAP sensitized hypoxic mammalian cells to x-rays (2300 rads) in the concentration ranges tested (0 to 10^{-2}M). Studies with isomers of PNAP showed that m-nitroacetophenone was less toxic, as well as less effective as a sensitizer, than either o-nitroacetophenone or PNAP. Mechanisms of toxicity and radiosensitization are discussed in relation to the electron affinities of the compounds. (UK)

38616 SEDIMENTATION ANALYSIS OF DNA FROM IRRADIATED AND UNIRRADIATED L-CELLS. McBurney, M. W.; Graham, F. L.; Whitmore, G. F. (Univ. of Toronto. Ontario Cancer Inst., Toronto). Biophys. J.; 12: No. 4, 369-83(Apr 1972).

DNA, released from unirradiated mouse L-cells gently lysed in a thin layer of 2% sucrose on top of an alkaline sucrose gradient, was found to sediment in a narrow band with a sedimentation coefficient of about 500S. Exposure of cells to increasing doses of x rays (89 to 712 rads) continuously reduced the DNA sedimentation velocity until, after about 890 rads, the DNA appeared in a narrow peak with a sedimentation coefficient of approximately 180S. As the dose given to cells was increased beyond 890 rads, the sedimentation coefficient of the DNA released continued to decrease and the sedimentation profiles now broadened in a manner consistent with the random production of single-strand breaks in the DNA. The DNA released from unirradiated cells (500S) is thought to be loosely aggregated and only partially single stranded. It is presumed that cells exposed to low doses of radiation release DNA with marked reductions in sedimentation coefficient because single-strand breaks produced in the DNA aid the alkaline denaturation process. By using the system to be described, it has been possible to demonstrate DNA repair (rejoining of x-ray-induced single-strand breaks) during postirradiation incubation of cells given doses as low as 400 rads. (auth)

38617 NEUROBLASTOMA CLONES: PROSTAGLANDIN VERSUS DIBUTYRYL CYCLIC AMP, 8-BENZYLTHIO-CYCLIC AMP, PHOSPHODIESTERASE INHIBITORS AND X-RAYS. Prasad, Kedar N. (Univ. of Colorado, Denver). Proc. Soc. Exp. Biol. Med.; 140: No. 1, 126-9(May 1972).

The effects of prostaglandin (PG)E1, dibutyryl cyclic AMP, 8-benzylthio-cyclic AMP, inhibitors of phosphodiesterase [papaverine and 4-(3-butoxy-4-methoxybenzyl)2-imidazolidinone], and x-irradiation on two neuroblastoma clones, NBA2 (1) and NBDB$^-$, were studied. In the NBDB$^-$ clone PGE1 was much more effective in causing morphological differentiation than any other differentiating agents. In the NBA2 (1) clone PGE1 was as effective as the other agents. Adenylate cyclase of both clones may be sensitive to PGE1. The phosphodiesterase level in clone NBA2 (1) is probably inhibited by other differentiating agents but this enzyme level in clone NBDB$^-$ either is too low to be of any significance or is insensitive to phosphodiesterase inhibitors. In clone NBDB$^-$ the biological property of the cell may be more important in initiating the morphological differentiation than the interaction between the cell and the surface of the culture dish. (auth)

38618 EFFECT OF OXYGEN ON DNA SINGLE-STRAND BREAKS PRODUCED BY IONIZING RADIATION IN MAMMALIAN CELLS. Palcic, B.; Skarsgard, L. D. (McMaster Univ., Hamilton, Ont.). Int. J. Radiat. Biol.; 21: No. 5, 417-33(May 1972).

Mouse L-60 cells were irradiated in O_2 or N_2 atmospheres (0.66 MeV γ rays from a ^{137}Cs source at dose rates of 332 rads/min and 382 rads/min) and DNA single-strand breaks were measured using alkaline sucrose gradients. It was found that the presence of oxygen increased the yield of single-strand breaks over a dose range 0 to 25 krads. The oxygen enhancement ratio (OER) was 2.9, a value comparable to the OER for its colony-forming ability in L-60 cells. This observation was made using two different sedimentation techniques. (UK)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 38597 and 38668.

38619 (AEC-tr-7306, pp 228-31) EFFECT OF THE CARCINOGENIC HYDROCARBON 3,4-BENZPYRENE ON THE SURVIVAL RATE OF IRRADIATED E. COLI K12. Mirson, I. M.; Vilenchik, M. M.; Runova, Yu. N.; Sukhorukov, B. I. Translated from Radiobiologiya; 11: No. 5, 792-3 (Sep-Oct 1971).

The effect of the carcinogenic polycyclic hydrocarbon 3,4-benzpyrene on the sensitivity of two strains of E. coli K12 to ultraviolet radiation, with one strain capable of splitting thymine dimers in the dark and the other a mutant in enzymes that catalyze this process was studied. It was shown that incubation with the carcinogen for one hour leads to increased sensitivity of cells of the first strain to ultraviolet radiation but has no effect on the sensitivity of the mutant cells. (auth)

38620 (AEC-tr-7306, pp 245-8) COMPARISON OF THE RELATIVE BIOLOGICAL EFFECTIVENESS OF BREMSSTRAHLUNG WITH END-POINT ENERGY OF 22 MeV AND ^{60}Co GAMMA RADIATION. Kovalev, V. P.; Kapchigashev, S. P.; Tsuladze, N. G. (Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 5, 801-3 (Sep-Oct 1971).

The RBE of bremsstrahlung with an end-point energy of 22 MeV was compared with that of cobalt-60 gamma radiation. The values of RBE after irradiation of yeast cells (Megri 139B) in a water phantom did not differ. The RBE of bremsstrahlung was 1.5 times greater after the object was irradiated outside the phantom. The difference can be explained by the contribution to the proton dose from the reaction (γ,p). (tr-auth)

38621 (ORNL-TM-3798) TESTING FOR THE MUTAGENICITY OF IRRADIATED PAPAYAS TO RATS IN A HOST-MEDIATED ASSAY WITH SALMONELLA TYPHIMURIUM AS INDICATOR ORGANISM. Smith, E. A.; Malling, H. V. (Oak Ridge National Lab., Tenn.). Apr 1972. 15p. Dep. NTIS.

The induction of reverse mutation in a histidine-requiring mutant (G-46) of Salmonella typhimurium was used as an indicator in a host-mediated assay with rats to study whether irradiation or papaya causes formation of mutagenic compounds or substances that might form mutagenic metabolites. The rats were fed irradiated papayas for a period of 8 to 12 weeks prior to the injection of the bacteria. In such experiments it is important to have positive controls. Dimethylnitrosamine (DMN) was used as a positive control, because this compound was shown earlier to induce reversions in strain G-46 in the host-mediated assay but not in vitro under nonhydroxylating conditions. (auth)

38622 (TID-26023) FACTORS CONTROLLING UV-INDUCED REVERSION IN SPORES OF BACILLUS SUBTILIS. Johnson III, Jesse Brealand (Texas Univ., Austin). Aug 1971. 69p. Dep. NTIS.

Thesis.

A technique for detecting uv-induced reversions from auxotrophy to protrophy of Bacillus subtilis (SB 25) spores has been demonstrated. Manipulations with exogenous L-histidine in the growth medium showed that there are specific times during germination and outgrowth that the irradiated spore requires the amino acid for fixation of the premutational lesion. Addition of histidine at progressive intervals after the initiation of germination indicated a slight dip during the first forty minutes, a rise to a peak, and then a significant biphasic decrease up to 24 hours in the number of mutants. Deletion of histidine at progressive intervals indicated that the time at which the spore no longer requires the amino acid for the fixation of the mutation is between 10-16 hours after the initiation of germination. It was suggested that DNA repair may be involved in the expression of the number of mutants, and that the times of the requirement for the amino acid for fixation might be correlated with the times of initiation of the several prominent events occurring in the germinating and outgrowing spore. This correlation is not possible at present because of a lack of experimental evidence concerning biochemical events occurring in the germinating and outgrowing spore under the experimental conditions used in this investigation. (auth)

38623 (TID-26024) EFFECTS OF INERT GASES ON THE RADIATION SENSITIVITY OF SPORES OF BACILLUS MEGATERIUM. Kimler, Bruce Franklin (Texas Univ., Austin). Dec 1971. 94p. Dep. NTIS.

Thesis.

Some effects of the inert gases on the radiation sensitivity of Bacillus megaterium spores were shown. The survival curves of spores irradiated in the dry state in an inert gas are biphasic. At low doses, the spores are more sensitive and at high doses they are less sensitive than spores irradiated wet in the same gas. Because of the lack of accurate dose rates in the various inert gases, it is not possible to calculate the absolute radiation sensitivity for spores irradiated under different inert gases. Also, as the atomic number of the gas increases, there is increased sensitization at the low doses and increased protection at the high doses. This result is independent of the dose rates used. These results are interpreted in terms of water structure within the spore. Known changes in radiation sensitivity were correlated with changes in the water structure in the spore. In these experiments, the relation of increasing atomic number of the gas to increasing change in sensitivity, together with the increased probability of water structure formation as the atomic number increases, suggests that the radiation sensitivity is the consequence of increased water structure in the spore. The increased sensitivity of the spores in the dry state at low doses can be explained by an increase in the conductance of energy through structured water to the important bimolecules, resulting in more damage to the spores. The biphasic nature of the survival curves can be explained by assuming that after sufficient energy was absorbed, the water structures were broken down. This would produce a lower energy conductance and therefore a lower sensitivity. Neither of these mechanisms were conclusively demonstrated and there are many other plausible mechanisms that might explain the results equally well. However, it was definitely shown that the inert gases do have an effect on the radiation sensitivity of bacterial spores and the evidence strongly indicates that this effect is mediated through ability of the inert gas to affect the water structure within the spores. (auth)

38624 GENETIC AND PHYSIOLOGICAL ANALYSIS OF UV-SENSITIVE MUTANTS OF SACCHAROMYCES CEREVISIAE. Parry, Elizabeth M.; Parry, James M.; Waters, R. (University Coll., Swansea, Eng.). Mutat. Res.; 15: No. 2, 135-46(Jun 1972).

The use of tetrad analysis and complementation tests indicates that the groups of uv-sensitive mutants assigned the labels rad I and rad 3 are alleles of two single genes involved in the process of cellular repair of uv-induced damage in the yeast Saccharomyces cerevisiae. UV exposure and the use of modifying treatments such as liquid holding and photoreactivating light demonstrate significant variation in the response of the different alleles to uv-induced lesions. The data indicate that both loci rad I and rad 3 are involved in the excision repair of uv-induced lesions. (auth)

38625 STUDIES ON THE STRUCTUREDNESS OF CYTOPLASM AND RATES OF ENZYMATIC HYDROLYSIS IN GROWING YEAST CELLS. I. CHANGES INDUCED BY IONIZING RADIATION. Cercek, Lea; Cercek, B. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 21: No. 5, 445-53(May 1972).

Changes in the structuredness of cytoplasm after irradiation with x-rays under oxic and hypoxic conditions in yeast cells (Saccharomyces cerevisiae) were studied. The fluorescence polarization of fluorescein was measured in molecules produced by enzymatic hydrolysis of the non-fluorescent fluorescein-diacetate (FDA) in the cytoplasm of cells in logarithmic phase of growth. The fluorescence polarization value of fluorescein molecules in the cytoplasm of yeast cells in the initial part of logarithmic phase of growth was $P = 0.165 \pm 0.0086$ at 27°C. This value increased progressively after irradiation in oxic conditions. After a dose of 16 Krads the fluorescence polarization value increased by 105%, indicating an increase in the structuredness or viscosity of the cytoplasm. Irradiation under hypoxic conditions decreased the fluorescence polarization by 10%. The decrease was constant from 1 Krad to 30 Krads. Rates for the enzymatic hydrolysis of FDA to fluorescein in vivo were measured. The first-order rate constants for the hydrolysis of FDA decreased (increased) with increasing (decreasing) structuredness of the cytoplasm. Good agreement with the theoretical correlation between viscosity of the matrix and reaction-rate constants of diffusion controlled reactions was obtained for the enzymatic hydrolysis of FDA in vivo. Effects of the structuredness of cell matrix on rates of enzyme reactions are discussed. (UK)

38626 GENETIC CONTROL OF SENSITIZATION BY OXYGEN INVOLVING REPAIR SYSTEMS IN SACCHAROMYCES. Averbeck, D.; Ebert, M. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 21: No. 5, 493-502 (May 1972).

Survival curves are presented for various strains of Saccharomyces after α irradiation over a dose range of 0 to 36 Krads. Radiation-sensitization by oxygen of the colony-forming ability was observed to the same extent in wild-type Saccharomyces and in mutant strains r_2^s, r_{3-1}^s and r_{3-2}^s. However, four independent spore clones containing the r_1^s gene, derived from asci after sporulation of diploid hybrid strains, showed the same sensitivity in oxic and hypoxic conditions. It was suggested that this lack of oxygen effect is therefore genetically linked to the r_1^s gene. The results are discussed in terms of the lack of repair capacity in the strains used. (UK)

38627 RADIOSTERILIZATION OF NUTRIENT MEDIA. Becking, J. H. (EURATOM-ITAL, Wageningen, Netherlands). Misc. Pap. Landbouwhogesch. Wageningen; 9: 55-87(1971).

The physical properties of ionizing radiation and its chemical and biological effects are discussed. Some useful sources of irradiation and the essentials of dosimetry are reviewed. A survey is given of the order of magnitude of the radiation sensitivity of various classes of microorganisms and of the various intrinsic factors influencing sensitivity values. The effects of radiation on the components of the nutrient media are summarized. The radiosterilization of liquid nutrient media is discussed, but also that of foodstuffs and soils, because the latter substrates are often used as nutrient media by food and soil microbiologists. (auth)

38628 SYNERGISTIC INACTIVATION OF VIRUSES BY HEAT AND IONIZING RADIATION. Trujillo, R.; Dugan, V. L. (Sandia Labs., Albuquerque, N. Mex.). Biophys. J.; 12: No. 1, 92-113 (Jan 1972).

Viral inactivation by heat and/or ionizing radiation is analyzed in terms of a kinetic model. The phenomenon of synergistic viral inactivation observed when viruses are exposed to the simultaneous application of heat and ionizing radiation is interpreted within the framework provided by this three-term model. Data on the inactivation of T4 bacteriophage by heat and/or ionizing radiation is presented, and the kinetic model is used to provide a description of observed dose rate and temperature dependences. Extension of the model to other viral systems inactivated by heat and ionizing radiation is considered, and the general applicability of these analyses suggests that the kinetic model may well serve as an extension of target theory in describing the radiobiological effects of ionizing radiation. (auth)

38629 LOCATION OF uvr502 MUTATION ON THE CHROMOSOME OF ESCHERICHIA COLI K-12. Smirnov, G. B.; Skavronskaya, A. G. (Inst. for Epidemiology and Microbiology, Moscow). Mol. Gen. Genet.; 113: No. 3, 217-21(1971).

The uvr502 mutation was mapped on the chromosome of E. coli K12 and the gene order was determined as ilv, uvr(502), metE. Tables are presented to show linkage between chromosome markers and the use of these data to deduce gene order is discussed. The relationship between mutability and ultraviolet sensitivity is described. (H.L.W.)

38630 DURATION OF RECOVERY AND DNA REPAIR IN EXCISION DEFICIENT DERIVATIVES OF ESCHERICHIA COLI K-12 AFTER ULTRAVIOLET IRRADIATION. Ganesan, Ann K.; Smith, Kendric C. (Stanford Univ., Calif.). Mol. Gen. Genet.; 113: No. 4, 285-96(1971).

Results indicate that cells of excision deficient (uvr) mutants of Escherichia coli K-12 which survive exposure to ultraviolet radiation may require several hours to complete their recovery. For example, the duration of the recovery period for cells exposed to 63 ergs mm^{-2} at 254 nm was about 5 hours, the equivalent of slightly more than 4 generations of the unirradiated controls. During the recovery period the rate of cell division was reduced, the cells gradually regained resistance to complex medium, and they became refractory to photoreactivation. Over the same period of time their pattern of DNA synthesis changed. More intact molecules, similar to those found in unirradiated controls, and relatively fewer discontinuous molecules were synthesized. (auth)

38631 EVIDENCE FOR EXTREME UV RESISTANCE OF MICROCOCCUS SP. NCTC 10785. Lewis, Norman F.; Kumta, Umesh S. (Bhabha Atomic Research Centre, Bombay). Biochem. Biophys. Res. Commun.; 47: No. 5, 1100-5(9 Jun 1972).

Micrococcus sp. NCTC 10785 isolated from irradiated Bombay duck (Harpodon nehereus) which was earlier found to be exceptionally resistant to gamma radiation, has also been shown to exhibit phenomenal resistance to ultraviolet (uv) radiation, higher than that reported so far for any other bacterium. The uv survival curve of this bacterium was found to be triphasic, comprising a very large shoulder extending up to 9,000 ergs/mm^2, an exponential part and a pronounced tail beginning at 25,000 ergs/mm^2 and extending well beyond 50,000 ergs/mm^2. The large shoulder presumably indicates operation of an extremely efficient repair mechanism. The distinct tailing effect is not due to genetic heterogeneity of population, since clones picked from the tail region showed the same triphasic response as the parental population. The type of tailing observed in the survival curve of this microorganism has not been shown previously for a bacterium exposed either to uv or ionizing radiation. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstracts 38596 and 38668.

38632 (AEC-tr—7306, pp 146-52) EFFECT OF γ IRRADIATION ON SOME CYTOPHYSIOLOGICAL AND BIOCHEMICAL PROCESSES IN GERMINATED PINE, FIR, AND SIBERIAN LARCH SEEDS. Sovershaev, P. F. (Inst. of Wood Technology, Arkhangelsk, USSR). Translated from Radiobiologiya; 11: No. 5, 737-41 (Sep-Oct 1971).

The effect of ionizing radiation on nucleic acid metabolism and the activity of some enzymes in germinated pine, fir, and larch seeds was studied. The seeds varied in radioresistance under both laboratory and field conditions. Irradiation at 100 and 250 R reduced the ground germinating capacity of the seeds and halted the growth of the seedlings on day 4 after soaking. The activity and localization of acid and alkaline phosphatases, peroxidase, and cholinesterase were determined. (tr-auth)

38633 (AEC-tr—7306, pp 232-5) EFFECT OF GAMMA RAYS ON SUSCEPTIBILITY OF A NONSPECIFIC HOST (PARTHENOCISSUS) TO POTATO X VIRUS INFECTION (IN TISSUE CULTURE). Anokhin, V. M.; Zhuk, I. P.; Didenko, L. F. (Inst. of Microbiology and Virology, Kiev). Translated from Radiobiologiya; 11: No. 5, 794-6(Sep-Oct 1971).

Tumor tissue from Parthenocissus, nonspecific with respect to potato X virus (PXV), was exposed to gamma rays at 500 to 8000 rad, infected with RNA from PXV, and its infectiousness determined. Only extracts from tissues irradiated at 2000 and 8000 rad proved to be infectious. The presence of newly formed virus particles in the callus was demonstrated by titration on Chenopodium amaranticolor, incubation with RNAase, and fluorescent antibodies method. (tr-auth)

38634 (AEC-tr—7306, pp 236-40) EFFECT OF HIGH ENERGY ELECTRONS ON SEEDS OF SUGAR BEET AND ONION HYBRIDS AND PARENTAL FORMS. Shestopalova, N. G.; Kirichenko, O. I. (Kharkov State Univ.). Translated from Radiobiologiya; 11: No. 5, 796-8(Sep-Oct 1971).

The effect of high energy electrons on the seeds of sugar beet and onion hybrids and parental forms (dose 10 to 100 krad) was studied. The number of cells with chromosomal aberrations and mitotic activity was estimated in the meristem of the roots. Differences in degree of radiosensitivity were noted between the hybrids and parental varieties. Irradiation had no effect on the rate at which the first mitoses appeared in the tissues of the original onion varieties but it inhibited the division of the hybrid. The number of cells with chromosomal aberrations was shown to increase at the end of the first postradiation mitosis. (tr-auth)

38635 (CEA-R—4300) SOME ECOLOGICAL AND BIOGEOGRAPHICAL ASPECTS OF THE CHRONIC GAMMA IRRADIATION OF A MEDITERRANEAN TYPE GROUND PHYTOCENOSE. Fabries, Michel (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Nov 1971. 100p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Toulouse Univ. (France).

The chronic gamma irradiation in situ of a terrestrial plant community began in July, 1969 at the Cadarache Nuclear Research Center using the newly installed 1,200 Ci ^{137}Cs source. The responses of the irradiated plant community depended on the Mediterranean climate. The flora included European, Asiatic, South

African, and subcosmopolitan species divided into two vegetation series—Quercus ilex L. series and Quercus pubescens Willd. series. The series were distributed according to topography. The dose-response relations were used to establish a scale of specific radiosensitivities in place of the classical lethal doses. Accordingly, the subcosmopolitan species were the least radiosensitive, the European species the most radiosensitive, and the Mediterranean species intermediate between the two extremes. The concept of auto-protection of populations and of individuals was established and the question of dormancy was investigated. Gamma radiation may be compared to an additional ecological factor introduced into a biologically balanced ecosystem. Severe perturbations occurred resulting in pronounced population dynamics. Analysis showed that biogeography and ecology act as detectors regarding the community response to ionizing radiation, enabling prediction of a relative radiosensitivity among species. (E.R.B.)

38636 (RLO–2221-T-2-11) DIFFERENTIAL EFFECT OF SODIUM AZIDE ON THE FREQUENCY OF RADIATION-INDUCED CHROMOSOME ABERRATIONS VS THE FREQUENCY OF RADIATION-INDUCED CHLOROPHYLL MUTATIONS IN HORDEUM VULGARE. Sideris, E. G.; Nilan, R. A. (Washington State Univ., Pullman. Dept. of Agronomy and Soils). [1971]. Contract AT(45-1)-2221. 23p. Dep. NTIS.

A remarkable synergistic increase of the frequency of the cells carrying chromosome aberrations was observed in seeds of Hordeum vulgare variety Himalaya irradiated with gamma rays and hydrated in sodium azide solutions buffered at pH 3, 7, and 11. This effect, which was most evident at pH 3, was present at least up to the formation of the male gametophyte. No parallel synergistic increase of the frequency of induced chlorophyll-deficient mutants was observed. Moreover, a sodium azide-induced mitotic delay was not concomitant with a DNA synthesis delay. This differential effect of the sodium azide post-irradiation treatment on the frequency of chromosome aberrations vs the frequency of mutations is attributed to the formation of two kinds of lesions in the genetic material of barley following exposure to gamma rays. One kind of lesion, similar to those leading to point mutations in procaryotes, is repairable at low energy potentials and, thus, its frequency is not affected by the sodium azide treatment. The other kind of lesion is associated with chromosome breaks and its repair is affected by the presence of the enzymatic inhibitor. (auth)

38637 (RLO–2221-T-2-13) STUDY OF FACTORS GOVERNING PLANT RADIOSENSITIVITY. Annual Progress Report. Nilan, Robert A.; Konzak, C. F. (Washington State Univ., Pullman). 1 May 1972. Contract AT(45-1)-2221. 30p. Dep. NTIS.

Progress is reported on the effect of azide on chromosomal repair in gamma-irradiated barley embryos; effects of azide on mutational events in irradiated and non-irradiated barley seeds; effects of hydroxylamine and caffeine on chromosomal repair; effects of peroxidase and catalase in mediating radiation damage; isolation of nuclei from barley embryos; and development of a rotary-rocker for DNA extraction. (H.L.W.)

38638 (SRO–637-1(Pt.1)) GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION AND CHEMICAL MUTAGENS ON GENETAL AND SPECIFIC COMBING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES. Progress Report, May 1, 1971–July 31, 1972. Burton, Glenn W.; Powell, Jerrel B.; Hanna, Wayne W. (Georgia Univ., Tifton. Georgia Coastal Plain Experiment Station). 1972. Contract AT(38-1)-637. 71p. Dep. NTIS.

Using a 9 × 9 lattice square design, forage yield of pearl millet was evaluated for general and specific combining ability. The singlecrosses tested were derived from inbred lines receiving three cycles of recurrent thermal neutron and ethyl methanesulfonate treatment. As in previous years, some of the calculated variance components were negative (43 of 108). Since the negative components have occurred all three years in tests conducted under good agronomic conditions, they are concluded to be an expression of variation in the 3 × 3 diallels with only nine entries. By allowing for positive variations with the same amplitude as the negative variations, five values were found to be larger than + 270 (the largest negative variance was − 270). Two 9 × 9 lattice square experiments devoted to measuring yields of 5 × 5 diallels gave only two negative genetic variances in 12 and these were small. In these tests the additive component was much larger than the non-additive component. Some inbred lines tested in 3 × 3 diallels were also tested as inbreds in a 9 × 9 lattice square test. Results revealed that inbred yields cannot replace 3 × 3 diallels in preliminary screening for combining ability. Seed of a number of singlecross components of 5 × 5 and 6 × 6 diallels was produced to be tested in 1972. Mutant 23S, a trichomeless line, in a pearl millet cafeteria containing 18 millets replicated 12 times was preferentially grazed. Cytogenetical investigations confirmed the discovery of a cytoplasmic inherited yellow striped leaf mutant. The knob-head mutant was shown to produce twin embryos and frequently twin caryopses. The short head mutant was simply inherited. Evidence that the stubby head mutant may be partially apomictic was obtained. All the above mutants are products of irradiation research carried out under this contract. Exposing dormant rhizomes of the sterile triploid turf bermudagrass hybrids has produced approximately 150 mutants. (auth)

38639 MUTATIONS INDUCED IN TRADESCANTA BY SMALL DOSES OF X-RAYS AND NEUTRONS: ANALYSIS OF DOSE-RESPONSE CURVES. Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.); Rossi, H. H. Science; 176: No. 4037, 916–18(26 May 1972).

Dose-response curves for pink somatic mutations in Tradescantia stamen hairs were analyzed after neutron and x-ray irradiation with doses ranging from a fraction of a rad to the region of saturation. The dose-effect relation for neutrons indicates a linear dependence from 0.01 to 8 rads; between 0.25 and 5 rads a linear dependence is indicated for x-rays also. As a consequence the relative biological effectiveness reaches a constant value (about 50) at low doses. The observations are in good agreement with the predictions of the theory of dual radiation action and support its interpretation of the effects of radiation on higher organisms. The doubling dose of x-rays was found to be nearly 1 rad. (auth)

38640 CYTOGENETIC ANALYSIS OF NEW FORMS OF COTTON (GOSSYPIUM HIRSUTUM L.) (2n = 52). Dzhabarov, Kh. (Inst. of Plant Physiology and Biophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 10, 59-61(1971). (In Russian).

Cotton seeds of the variety 2421-U were treated with ^{60}Co γ rays (20 kR) and 0.07% solution of ethyleneimine for the purpose of effecting mutations. All mutations exhibited normal sporogenesis. Analysis of pollen cells with tetrads showed that cells with normal tetrads were encountered in more than 90%. Viability of cells and seed productivity amounted to 90% and 80%, respectively. Morphological signs by which mutations could be separated during three generations were stable. It was concluded that the nature of the cotton mutants obtained had a genic origin. (K.S.W.)

38641 EVALUATION OF THE SAMPLE ROTATION METHOD FOR THE MEASUREMENT OF GAMMA ACTIVITY IN LARGE INHOMOGENOUS SAMPLES OF BIOLOGICAL MATERIAL. Harmut, Magda; Simonovic, I.; Popovic, S.; Jovanovic, V. (Univ., Zagreb). Arh. Hig. Rada Toksikol.; 21: 247-54(1971).

The sample rotation method was evaluated with an instrument partly constructed at the Institute for Medical Research and Occupational Health. The purpose of our investigation was to find the optimal compromise between the sensitivity of the instrument and the measuring error due to the inhomogeneity of the sample. The method was evaluated with ^{85}Sr and ^{47}Ca. On the basis of the experimental data it was concluded that for the determination of radioactivity in large samples of biological material a relatively modest instrument accessible to all clinical radioisotope operating institutions can be used. (auth)

38642 EFFECT OF GAMMA-RAYS ON CALLUS-FORMATION IN PEA PLANTS. Izvorska, N. D. (Inst. of Plant Physiology, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 8, 1085-7(1971).

Seeds of peas were irradiated with 500, 1000, and 5000 R doses of gamma radiation and explants of roots, stems, and leaves were grown on culture media with dichlorophenoxy acid. The 500 R dose was most effective in enhancing the growth of calluses; an inhibitory effect was observed with a dose of 5000 R. Calluses from roots, stems, and leaves are compared with regard to structure of the callus and tables are presented to show effects of radiation dose on growth of calluses in roots, stems, and leaves. (H.L.W.)

Radiation Effects on Animals (External Source)

Man

Refer also to abstracts 38327, 40052, and 40078.

38643 (LIB/Trans–362) APPLICATION OF A FEW SPECIFIC METHODS IN BIOLOGICAL DOSIMETRY IN THE DEPARTMENT FOR MEDICAL PROTECTION OF THE "BORIS KIDRIC" INSTITUTE OF NUCLEAR SCIENCES. Aleksic, B.; Veljkovic, D.; Djordjevic, O.; Djukic, Z. Translated by M. Ganez for Australian Atomic Energy Commission, from pp 687–95 of report STI/PUB–269. 13p. Dep. NTIS (U.S. Sales Only).

An abstract of this item prepared from the original appeared as NSA 25: 58018 (1971). (Australia)

38644 (TID-26035) HISTOLOGIC STUDY OF ORAL TISSUE SPECIMENS OF NEW JERSEY DIAL PAINTERS. Period Covered: July 1, 1962–June 24, 1971. Bernier, Joseph L. (Georgetown Univ., Washington, D. C. School of Dentistry). 15 May 1972. Contract AT(30-1)-3879. 7p. Dep. NTIS.

Oral tissue specimens from 27 persons who used luminous paints containing radium while employed early in life as watch dial painters were examined histologically for evidence of radio-induced pathological changes. No significant changes were observed in soft tissue specimens. All specimens from the mandible and maxilla showed chronic localized osteomyelitis and bone scar and evidence of poorly formed bone. (C.H.)

38645 RADIATION TOLERANCE OF THE NORMAL TISSUES OF THE LARYNX. ITS IMPLICATIONS IN RADIOTHERAPY. Aristizabal, Silvio A.; Caldwell, William L. (Vanderbilt Univ., Nashville). Radiology; 103: No. 2, 419-22(May 1972).

On the basis of personal results and reports of others, it was concluded that in well-differentiated squamous-cell laryngeal carcinoma the standard dose of 6,000 rads ^{60}Co γ radiation in 30 treatments over six weeks (NSD of 1,770 rets) is inadequate when megavoltage is used. For T_1N_0 and T_2N_0 lesions a tumor dose biologically equivalent to at least 6,000 rads in five weeks with 5 treatments per week (1,900 rets) is recommended. This is below the tolerance dose of the larynx. For T_3N_0 lesions a dose biologically equivalent to at least 7,200 rads in six weeks with 5 treatments per week (2,100 rets) is suggested. (auth)

38646 CARCINOMA OF THE CERVIX. A 7-YEAR STUDY ON 1,212 CASES TREATED AT FONDATION CURIE, PARIS. Rousseau, J.; Fenton, J.; Debertrand, Ph.; Mathieu, G. (Fondation Curie, Paris). Radiology: 103: No. 2, 413-18(May 1972).

In 1,212 cases of carcinoma of the uterine cervix treated by intracavitary ^{226}Ra γ, external γ and x radiation and surgery in various combinations the 5-year cure rate was 83% for Stage I cases, 51% for Stage II cases, 28% for Stage III cases, and 13% for Stage IV cases. The overall cure rate was 50.5%. Five- and ten-year cure rates for therapeutic radiation alone were 77 and 69%; for irradiation and surgery, 86 and 63%. Preoperative external irradiation seemed to improve the 5-year cure rate; postoperative irradiation for pelvic lymph node involvement had poor results. The incidence of complications following radiotherapy was moderately high, 218 out of 1,212 cases (17%). The majority of the complications were rectal or vesical, and most were mild. (C.H.)

38647 ACTIVE BONE-MARROW DOSE RELATED TO HEMATOLOGICAL CHANGES IN WHOLE-BODY AND PARTIAL-BODY ^{60}Co GAMMA RADIATION EXPOSURES. Kereiakes, James G.; Van de Riet, William; Born, Clifford; (and others) (Cincinnati General Hospital). Radiology; 103: No. 3, 651-6(Jun 1972).

The radiation dose to active bone marrow was investigated as a parameter for hematological changes in man resulting from whole-body and partial-body exposures to ^{60}Co γ radiation. Dose distributions in active bone marrow were measured in a tissue-equivalent human phantom. Dose equivalents for the partial-body exposure conditions were determined by applying the phantom marrow dose distributions to a model for nonuniform exposure based on stem-cell dose-survival curves. The model was extended to predict hematological changes which agree favorably with the observed clinical changes. (auth)

38648 PATHOGENESIS OF RADIATION-RELATED LEUKAEMIA AND LYMPHOMA. SPECULATIONS BASED PRIMARILY ON EXPERIENCE OF HIROSHIMA AND NAGASAKI. Anderson, Robert E.; Nishiyama, Hiroshi; Ii, Yohei; Ishida, Kenzo; Okabe, Nobukazu (Atomic Bomb Casualty Commission, Hiroshima. Atomic Bomb Casualty Commission, Nagasaki. Univ. of New Mexico, Albuquerque). Lancet; 1: No. 7759, 1060-2(13 May 1972).

It is pointed out that malignant lymphomas and the leukemias are thought to have much in common, but the prevalence of the two diseases in populations exposed to ionizing radiation is very different. It is suggested that experimental and clinical evidence points to the pathogenesis of the two conditions being different; leukemia, with a low radiation threshold, being caused by bone-marrow hypoplasia, while lymphoma is induced at higher radiation doses which affect the body's immune system. Support for this view comes from experience of the atomic-bomb survivors at Hiroshima and Nagasaki. (UK)

38649 DOSE-RESPONSE RELATIONSHIP FOR CHROMOSOME ABERRATIONS INDUCED BY X-RAYS OR 50 MeV PROTONS IN HUMAN PERIPHERAL LYMPHOCYTES. Todorov, S. L. (Inst. of Radiology and Radiation Hygiene, Sofia); Grigor'ev, Yu. G.; Rizhov, N. I.; (and others). Mutat. Res.; 15: No. 2, 215-20(Jun 1972).

The dose–response relationship was investigated for chromosome aberration yields produced in human peripheral lymphocytes by exposure to x rays or 50 MeV protons in vitro. Both sets of data on dicentric aberrations were fitted to the power law expression $Y = bD^n$, with dose exponents of 1.47 ± 0.012 and 1.36 ± 0.027 for x-rays and protons, respectively. The proton RBE (relative biological efficiency) value obtained was 0.88 ± 0.01. (auth)

38650 NEUROPATHOLOGIC STUDY OF FOURTEEN CASES OF MALIGNANT BRAIN TUMOR TREATED BY ^{10}B SLOW NEUTRON CAPTURE RADIATION. Asbury, Arthur K.; Ojemann, Robert G.; Nielsen, Surl L.; Sweet, William H. (Massachusetts General Hospital, Boston). Contract AT(30-1)-1093. J. Neuropathol. Exp. Neurol.; 31: No. 2, 278-303(Apr 1972).

Neuropathologic observations on fourteen cases of malignant brain tumor treated by boron 10-slow neutron capture radiation at open craniotomy are presented. Extensive radiation necrosis was the major finding in nine, residual tumor in two, a combination of radiation necrosis and tumor in one, massive intracerebral hemorrhage in one, and acute bacterial meningitis in one. Varying amounts of residual neoplasm were detected in all instances except two, in which none could be found. Radiation necrosis was characterized by coagulation of devitalized tissue with failure of the usual liquefactive chain of events and by striking blood vessel affection. The relationship between radiation necrosis, residual tumor, and neutron flux is demonstrated topographically in several cases. (auth)

38651 REVIEW AND ANALYSIS OF RADIATION ACCIDENTS. Brunner, H. Strahlenschutz Forsch. Prax.; 11: 1-11(1971). (In German).

Injuries to the whole body, hands, and skin of man following exposure during radiation accidents are reviewed. Also discussed is the incorporation of radioactive materials by inhalation, ingestion, injection, and skin penetration. External contamination of the skin, hair, and clothing is considered. (H.B.G.)

38652 CELL KINETIC BASIS OF WHOLE-BODY IRRADIATION SYNDROME. (PATHOLOGY OF RADIATION INJURIES). Cottier, H.; Buerki, H.; Graepel, P.; Laissue, J. Strahlenschutz Forsch. Prax.; 11: 47-54(1971). (In German).

Pathological changes following whole-body exposure of mammals to ionizing radiation are reviewed. Radiation effects on tissues with a high turnover-rate such as the hematopoietic system and gastrointestinal epithelium are discussed. The time relation between turnover rate and development of clinical symptoms is outlined. (H.B.G.)

38653 EFFECT OF RADIATION AND CHEMOTHERAPY ON A GRANULOCYTE RESERVE OF THE BONE MARROW IN PATIENTS WITH CANCER OF THE GENITALIA. Kosareva, A. N.; Turbina, I. L.; Urvantseva, N. V. (Inst. of Oncology, Leningrad). Vop. Onkol.; 17: No. 12, 38-9(1971). (In Russian).

Based on alterations in a granulocyte count of the bone marrow in patients with cancer of the genital organs after irradiation and chemotherapy, it was concluded that application of cytostatics (chemotherapy) produced a more pronounced deterioration in the bone marrow function in patients with cancer of the genital organs than ionizing radiation. (auth)

38654 EFFECTS OF TREATMENT WITH RADON WATERS IN SWIERADOW SPA ON TISSUE BLOOD FLOW DETERMINED BY MEANS OF RADIOACTIVE XENON. Halawa, Bogumil; Rog-Malinowski, Miron; Milewicz, Andrzej (Medical Academy, Wroclaw). Bull. Pol. Med. Sci. Hist.; 12: 185-6(Oct 1969).

The changes in tissue blood flow in the lower extremities in patients treated with radon-water baths in Swieradow spa were investigated using a method employing radioactive xenon. The results demonstrated an increase of the tissue blood flow, particularly marked in the group of patients with atherosclerotic disease of lower extremities. The increase of tissue blood flow may depend on urinary elimination of cathecholamines from the organism with resulting decreased tendency of blood vessels to prolonged spasm, or on activation of the fibrinolytic system with release of plasma kinins dilating the capillary vascular bed. (auth)

38655 NORMAL COURSE OF A PREGNANCY EXPOSED IN THE SECOND MONTH TO MECHANICAL MANEUVERS AND ACTINIC IRRADIATION. Fossati, S. Minerva Ginecol.; 23: 912-16(15 Nov 1971). (In Italian).

A case of pregnancy followed to term and for several months afterwards is reported, in which exposure to x rays and mechanical maneuvers undertaken in the 2nd month, due to an evaluation error, was apparently not responsible for any harmful effect. While attention is drawn to the need for close observation of the well-known rules of caution applicable to x-ray or mechanical intervention in the first 3 months of pregnancy, it is stressed that care should also be used in reaching a final medicolegal judgment on the cause of a supposedly criminal abortion. (auth)

38656 LONG-TERM COMPLICATIONS OF BETA-RADIATION THERAPY IN OPHTHALMOLOGY. Barron, Arnold; McDonald, James E.; Hughes, William F. (Univ. of Illinois, Chicago. Presbyterian-St. Luke's Hospital, Chicago). Trans. Amer. Ophthalmol. Soc.; 68: 113-28(1970).

After re-examining 71 patients 5 to 21 yrs following beta-radiation therapy for external ocular conditions, it has become evident that the doses used in the early stages of development of this treatment were unnecessarily high and led in many instances to late complications. However, most of these were tolerable, including development of lens vacuoles in the equatorial region of the lens which then usually migrated posteriorly to the subcapsular region. This rarely caused any diminution of vision and the opacities tended to be stationary, perhaps because of the highly localized nature of the irradiation. It would therefore seem reasonable not to discard this mode of therapy in conditions where it is superior to other methods or in conditions where other methods have failed. Reduction of the size of the dose and greater fractionation of doses can be expected to reduce the incidence of late changes caused by radiation. (auth)

38657 POPULATION DOSE IN MAN-REM BY THE ENVIRONMENTAL RADIATION DUE TO NUCLEAR POWER PRODUCTION. Tajima, Eizo (Rikkyo Univ., Japan); Ichikawa, Ryushi; Kuwashima, Kaneomi. Nippon Genshiryoku Gakkishi; 14: No. 3, 131-7 (Mar 1972). (In Japanese).

An estimate is presented on the exposure of the Japanese population to environmental radioactivity from nuclear power plants and fuel reprocessing facilities. There are two main sources of radiation exposure to the population. The first is the contribution from atmospheric ^{85}Kr and hydrospheric ^{3}H that originate from world-wide nuclear power production. The second component of population exposure derives from atmospheric and coastal releases of both airborne and liquid radioactive wastes from nuclear facilities installed in Japan. Assuming that the nuclear power generating capacity of the whole world will be 4,300 GWe and that for Japan alone will be 220 GWe in the year 2000, it is estimated that the above-mentioned exposure pathways will give rise to a dose rate of 1.7×10^4 man-rem/yr for the Japanese population. (auth)

38658 FRACTIONATION IN RADIOTHERAPY. PART 1. THEORETICAL ANALYSIS. Kiviniitty, K.; Harvala, A.; Pitkaenen, U.; Taskinen, P. J. (Oulu Univ., Finland). Ann. Chir. Gynaecol. Fenn., Suppl.; 60: No. 178, 1-22(1971).

Seven methods of fractionation were compared with the help of Cohen's mathematical model. The fractionation schemes were also compared in relation to integral damage. The analysis was theoretical, there were no clinical comparisons. It was possible to establish the best fractionation models in this way. (Finland)

38659 USE OF PD-030 (REDUCED FORM GLUTATHIONE PREPARATION) FOR RADIATION SICKNESS AND LEUCOPENIA DURING RADIOTHERAPY OF UTERINE CARCINOMA. Yoshimoto, Tadahiro; Sone, Hiroshi; Tanaka, Chiharu; Kurobe, Itaru; Koyama, Koji (Tokushima Univ., Japan). Shinryo To Shinyaku; 7: No. 11, 2127-35(Nov 1970). (In Japanese).

Comparative examinations were made on the effect of PD-030, a preparation of the reduced form of glutathione, on radiation sickness produced by radiotherapy in a total of 24 cases of uterine cervical carcinoma (15 cases of Stage I, 7 cases of Stage II, 1 case of Stage III) and one case of uterine body carcinoma. These cases were divided into three groups to be given 100, 300, or 500 mg of PD-030 by intravenous injection 30 to 60 minutes before irradiation of 1000 rad. Symptoms of radiation sickness were examined during the period of irradiation beginning with 1000 rad until the completion of the expected dose (6000 to 7000 rad). After irradiation of 1000 rad, side effects found in the control group were anorexia, vomiting, systemic fatigue, heaviness in the head, vertigo, and diarrhea, while these numbers were reduced in the groups given 100, 300, or 500 mg of PD-030. The observation through the whole period of radiotherapy indicated that anorexia, vomiting, and systemic fatigue were found sporadically in the groups given PD-030, but there was no incidence of headache, heaviness in the head, vertigo, or singing in the ear, and the incidence of diarrhea was difficult to judge. The radiation therapy was discontinued due to radiation sickness in five cases of the group given 100 mg and one case in the group given 300 mg of PD-030, and none in the group given 500 mg. The number of erythrocytes, leukocytes, and hemoglobin content was measured at the time of 1000, 2000, 3000, 4000, 5000, and 6000 rad irradiation, and measurements were also made on serum protein, A/G ratio, GOT, GPT, CCF, TTT, serum bilirubin, and serum alkaline phosphatase before, during, and after irradiation. (Japan)

38660 CYTOGENETIC CHANGES OF THE BONE MARROW AND LEUCOCYTES OF THE PERIPHERAL BLOOD IN RADIATION THERAPY OF CARCINOMA OF THE UTERINE CERVIX. Ryabukha, A. K.; Gabelov, A. A.; Zabalueva, I. I.; Naumova, N. S.; Kogan, V. E. (Central Scientific-Research Inst. of Roentgeno-Radiology, Leningrad). Med. Radiol.; 17: No. 5, 10-16(May 1972). (In Russian).

During radiotherapy of human cervical carcinoma it was calculated, with the aid of phantoms, that doses between 1500 and 3000 rad induced changes in hematopoietic function of pelvic bones. Analyses of metaphases were made to determine correlations between dose and chromosomal aberrations in blood cells. The appearance of translocations, ring chromosomes, and multiple fragmentation within the dose range of 712 to 2708 rad made it possible to establish threshold values below which changes did not appear. (H.L.W.)

38661 OSTEORADIONECROSIS OF THE JAWS. Hatziotis, J. Ch.; Papanayotou, P. Stoma (Thessaloniki); 1: 57-71(Mar-Apr 1969). (In Greek).

A danger of osteoradionecrosis of the jaws exists in every case of irradiation in the region of the mouth, pharynx, or neck. The greater the amount of irradiation, the greater the danger of osteoradionecrosis. The mandible is more apt to develop radionecrosis than the maxilla. The treatment of such cases is very difficult and for this reason prevention is essential. Preventive measures are as follows: an attempt should be made during the radiotherapy to give the least possible doses to the jaws, especially the mandible; the extraction, before or during the first days of radiotherapy, of all teeth in the part of the mandible that will receive irradiation; and good hygiene of the mouth; the use of dentures must be postponed for at least one year after radiotherapy. The extraction of a tooth in the irradiated portion of a jaw must be avoided. If this is impossible, the extraction must be performed under antibiotic therapy and with the minimum possible trauma. Three cases of osteoradionecrosis of the mandible are reported. (auth)

38662 ACCIDENTAL ^{60}Co EXPOSURE AT THE UNIVERSITY OF TENNESSEE–ATOMIC ENERGY COMMISSION AGRICULTURAL RESEARCH LABORATORY. Wade, Leo Jr. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.). Nucl. Safety; 13: No. 4, 304-8(Jul-Aug 1972).

A research technician entered a ^{60}Co irradiation facility at the University of Tennessee–Atomic Energy Commission Agricultural Research Laboratory in Oak Ridge, Tenn., and received a total-body exposure of 260 R. Contributing factors in the incident were malfunctioning interlock systems, failure to observe warning devices, and failure to follow established procedures. Several physical and administrative controls have been added to prevent the recurrence of such an incident. (auth)

38663 EFFECTIVENESS OF CHEMOTHERAPY OF RADIATION-INDUCED CANCER OF THE SKIN. Vitkin, B. S. Med. Radiol.; 17: No. 5, 21-6(May 1972). (In Russian).

The treatment of 35 patients with late radiation injuries of the skin degenerating into cancer is analyzed. Time-periods from the initiation of irradiation till the emergence of cancer were from 5 to 50 years. The treatment consisted in application of a 1.5 to 2% colchamine ointment in association with the sodium salt of usnic acid. In 26 patients followed up over a period of 2 to 6 years the treatment proved beneficial, in 5 cases relapses were observed. In 5 patients the cure was ineffective. (auth)

38664 ANGIOSARCOMA OF THE TEMPORAL REGION FOLLOWING ROENTGEN THERAPY OF HEMANGIOMA OF THE CHEEK. Podlyaschuk, E. L. (Scientific-Research Inst. of Roentgeno-Radiology, Moscow). Med. Radiol.; 17: No. 5, 26-30(May 1972). (In Russian).

A case-report of a girl-patient aged 14 is presented in whom, 12 years after a massive course of x-ray therapy for hemangioma of the left cheek and infraorbital region, an angiosarcoma of the left temporal region developed, extending to the orbit, destroying bone tissues at the juncture of the frontal, temporal, and parietal bones and attended by corresponding neurological symptoms. (auth)

38665 RADIATION CANCER OF THE THORACIC OESOPHAGUS. Chudecki, B. (Royal Devon and Exeter Hospital, Eng.). Brit. J. Radiol.; 45: No. 532, 303-5(Apr 1972).

The criteria for a diagnosis of radiation cancer are briefly reviewed in relation to cancer of the pharynx and esophagus. A case history is presented of a radiation induced squamous carcinoma of the thoracic esophagus in a man age 50 yr. It manifested itself 10 yr after apparently curative radiation therapy to a thoracic lymphosarcoma (22 fractions over 32 days, estimated dose 2,500 to 2,600 R). (UK)

38666 ASSESSMENT OF THE EFFECT ON RENAL FUNCTION OF IRRADIATION FOR TESTICULAR TUMOURS. Goodman, G. B.; Price, J. D. E.; Batho, H. F. (Univ. of British Columbia, Vancouver). Clin. Radiol.; 23: No. 2, 235-45(Apr 1972).

The renal function of a "special study" group of 7 patients and a "long-term study" group of 10 patients, all of whom had testicular tumors, was measured by means of specific kidney function tests before, during and for periods up to 5 years following ^{60}Co irradiation of regional lymphatic glandular areas. The treatment involved partial exposure of the kidneys to maximum doses ranging from 3,000 to 4,170 rads but in no case was there total exposure of both kidneys. The renal function of these patients was, on the average, about 12 percent below normal before radiotherapy started and decreased by an average of a further 7 percent during the course of the study but there was little correlation between the risk of radiation injury as measured by the average dose to renal tissue and decrease of kidney function following radiotherapy. It was a consistent finding that the clearance of sodium paraminohippurate was low as compared with the results of other tests both before and after radiotherapy. Comparison of the conclusions from this study with those of other investigators suggests that it may be important to avoid total exposure of both kidneys. (auth)

38667 CHANGES IN INTESTINAL AND RENAL FUNCTION AFTER PELVIC IRRADIATION: CORRELATION OF CLINICAL AND EXPERIMENTAL OBSERVATIONS. Goldberg, David M. (Royal Hospital, Sheffield, Eng.). Clin. Radiol.; 23: No. 2, 225-34(Apr 1972).

A group of tests for intestinal and renal function were carried out in female patients with carcinoma of the uterine cervix before and after treatment with a combination of intracavitary radium and orthovoltage or supervoltage radiotherapy. The results were statically evaluated and correlated with the effects of radiation known from previous clinical reports and experimental studies in animal models. No change in the concentration of urea and creatinine in serum took place, and the urea clearance (which was uncorrected for body surface area and therefore low in a number of patients prior to therapy) was likewise unaltered by therapy. A small (15 percent) but statistically significant reduction in creatinine clearance was observed after therapy. Serum xylose levels 2 hours after a loading dose were significantly reduced, but since the 5-hour urinary excretion of xylose was not significantly altered by therapy, it is likely that delay in stomach emptying contributed to the change in serum xylose concentration. Mean daily faecal excretion of nitrogen and fat were unaltered, but the percentage of fat relative to dry weight of the stool increased, possibly as a consequence of an increase in the rate of intestinal cell desquamation. A highly significant fall in the value for the Schilling test took place after radiotherapy. While reduced glomerular filtration rate and increased utilization of Vitamin B_{12} may have contributed, the main reason for the reduction was thought to be impaired Vitamin B_{12} absorption from the ileum. It is suggested that reduction in ileal function should be kept in mind in planning the nutritional requirements of anemic subjects during pelvic irradiation, while the fall in glomerular filtration rate may lead to the prolonged action of drugs normally cleared by this mechanism. (auth)

Vertebrates

Refer also to abstracts 38591–38595 and 38607–38609.

38668 (AEC-tr–7306) RADIOBIOLOGY, VOL. 11, NO. 5, 1971. Translation of Radiobiologiya; 11: No. 5, 643-808(Sep-Oct 1971). 254p. Dep. NTIS.

Separate abstracts were prepared for each of the 37 papers in this cover-to-cover translation. (E.R.B.)

For abstracts of individual papers see: 38591–38595, 38605–38611, 38619, 38620, 38632–38634, 38669–38685, 38759, 38760, and 38802.

38669 (AEC-tr–7306, pp 40-5) EFFECT OF IONIZING RADIATION ON THE AMYLOLYTIC ACTIVITY OF THE PANCREAS AND SMALL INTESTINE. Mikhaylov, V. N. (Central Research Inst. of Roentgenology and Radiology, Leningrad). Translated from Radiobiologiya; 11: No. 5, 669-72(Sep-Oct 1971).

X irradiation at 1200 R was shown to stimulate enzymic activity in the rat pancreas during the first hours after exposure; enzymic activity then decreased gradually. Enzymic activity progressively increased in blood serum but exhibited phase changes in small intestine homogenates. Phase changes occurred in membrane digestion after perfusion of the small intestine in experiments in situ, with starch hydrolysis intensifying 24 hrs after irradiation. (tr-auth)

38670 (AEC-tr–7306, pp 46-54) STUDY OF NUCLEAR PROTEIN METABOLISM IN ORGANS OF IRRADIATED ANIMALS. Paskevich, I. F.; Ishkhanova, M. A.; Likhoded, V. S. (Research Inst. of Medical Radiology, Kharkov). Translated from Radiobiologiya; 11: No. 5, 673-8(Sep-Oct 1971).

The biosynthesis of nuclear globulins, acid and residual proteins, and DNP in the liver and spleen of white rats 2, 24, 48, 72, 96, and 120 hrs after irradiation at 800 R was studied. Irradiation stimulated the synthesis of all the nuclear fractions in the liver after 24, 48, and 72 hrs; specific radioactivity decreased thereafter. In the spleen, incorporation of the label into the protein fractions under study was inhibited at all stages of the experiment. (tr-auth)

38671 (AEC-tr–7306, pp 81-8) RADIOSENSITIVITY OF CHROMOSOMES IN SOUND-RESISTANT AND SOUND-SENSITIVE WISTAR RATS. Logvinova, V. V.; Kerkis, Yu. Ya. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Translated from Radiobiologiya; 11: No. 5, 696-700(Sep-Oct 1971).

The radiosensitivity of chromosomes in corneal cells of intact and adrenalectomized rats sensitive and resistant to sound was compared. The radiosensitivity of the chromosomes was significantly higher in intact, sound-resistant animals ($P = 0.95$). This was not true of the adrenalectomized animals. Changes in chromosome radiosensitivity were noted in experiments performed at different times of the year. No differences in the mitotic activity of the cornea were found between groups of rats sensitive and resistant to sound with intact and ablated adrenals. However, mitotic activity was markedly different from one season to another. There is a discussion of the involvement of neuroendocrine relations in determining the individual radiosensitivity of the chromosome apparatus. (tr-auth)

38672 (AEC-tr–7306, pp 89-96) INTERACTION OF LYMPHOCYTES WITH SYNGENEIC STEM CELLS FROM IRRADIATED DONORS: ESTIMATION OF ANTIBODY- AND COLONY-FORMING ABILITY. Petrov, R. V.; Cheredeev, A. N. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 701-5(Sep-Oct 1971).

Use of the Till–McCulloch method revealed that splenic colony-forming units (CFU) from irradiated CBA mice (600 R) were not subjected to allogeneic inhibition in the F_1 (CBAXC57BL) hybrid 14 and 21 days after irradiation. The addition of syngeneic lymphocytes abolished the effect of cancellation of allogeneic inhibition. It is conjectured that nonmanifested splenic CFU are drawn into the immune reaction against the foreign environment of the F_1 recipient under the influence of syngeneic lymphocytes. The syngeneic combination revealed a synergetic interaction of the spleen cells of irradiated donors with the syngeneic lymphocytes in response to the accumulation of producers of antibodies against sheep erythrocytes. (tr-auth)

38673 (AEC-tr–7306, pp 118-24) EFFECT OF PLANT POLYPHENOLS ON ENERGY METABOLISM AFTER IRRADIATION. Shamray, E. A.; Alferov, A. N. (Research Inst. of Roentgenology, Radiology, and Oncology, Kiev). Translated from Radiobiologiya; 11: No. 5, 718-22(Sep-Oct 1971).

Injection of rats with 150 mg/kg of oats polyphenols before and after irradiation with median lethal and lethal doses of x rays had a beneficial effect on the normalization of oxygen uptake and esterification of inorganic phosphate in liver mitochondria. Injection of rabbits with polyphenols after local irradiation of the liver at 6000 R had a more favorable effect on the normalization of energy metabolism than did median lethal doses of whole-body irradiation. (tr-auth)

38674 (AEC-tr–7306, pp 131-8) MEXAMINE AS AN AGENT FOR INCREASING THE ANTITUMOR EFFECT OF IRRADIATION IN ANIMALS. Berezhnova, L. I.; Rampan, Yu. I.; Yarmonenko, S. P. (Inst. of Experimental and Clinical Oncology, Moscow). Translated from Radiobiologiya; 11: No. 5, 727-31(Sep-Oct 1971).

Experiments on 300 white mice with spontaneous mammary carcinoma revealed that 5-methoxytryptamine has an antitumor action. It also increases the local effect of preliminary irradiation of the tumor as manifested by inhibition of tumor growth and prolongation of the life of the animals. (tr-auth)

38675 (AEC-tr–7306, pp 139-45) FUNCTION OF SOME DIVISIONS OF THE CENTRAL NERVOUS SYSTEM IN INTEROCEPTIVE REFLEXES AFTER IRRADIATION. Lapshin, N. A. (Military-Medical Academy, Leningrad). Translated from Radiobiologiya; 11: No. 5, 732-6(Sep-Oct 1971).

The development, magnitude, and nature of reflexes after irradiation vary not so much with the state of the apparatus directly responsible for the reflexes as with the functional changes in many centers and their interaction at the different levels of the central nervous system. (tr-auth)

38676 (AEC-tr-7306, pp 169-74) STUDY OF RADIOSENSITIVITY OF THYROXINE INDUCTION OF UREA-FORMING ENZYMES IN RANA TEMPORARIA TADPOLES. Kuzin, A. M.; Slozhenikina, L. V.; Migushina, V. L. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 5, 754-7 (Sep-Oct 1971).

Irradiation of Rana temporaria tadpoles at 6 kR had no effect on thyroxine-induced synthesis of urea-forming enzymes. A dose of 15 kR abolished the inducing effect of the hormone on urea synthesis. The results show that the macromolecular system of enzyme synthesis is comparatively radioresistant. It is conjectured that the synthesis of the low molecular effector (thyroxine) is radiosensitive. (tr-auth)

38677 (AEC-tr-7306, pp 175-9) USE OF ADENINE-8-^{14}C TO ESTIMATE THE EFFECT OF RADIATION ON SYSTEMS OF OXIDATIVE RESYNTHESIS OF MACROERGIC PHOSPHATES. Voskovoynikov, G. V.; Shutko, A. N. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Translated from Radiobiologiya; 11: No. 5, 757-60 (Sep-Oct 1971).

It is suggested that the effect of radiation on the oxidative resynthesis of macroergic compounds be evaluated in in vivo experiments from the rate of incorporation of adenine-8-^{14}C into ATP whose content in rat tissues diminished sharply as a result of preliminary injection with ethionine. The intensity of incorporation of the label into ATP, ADP, AMP, and s-adenosylethionine (s-AEt) in rat liver during the first few hours and on the second day after irradiation was shown to be the same as the control. The dynamics of s-AEt accumulation and change in ATP concentration in the liver of the control and irradiated animals show, in my opinion, that the systems of oxidative resynthesis of macroergic compounds in hepatocytes are resistant to radiation. (auth)

38678 (AEC-tr-7306, pp 180-6) COMPARISON OF THE EFFECTS OF BETATRON RADIATION WITH AN ENERGY OF 25 MeV AND ^{60}Co RAYS ON SOME ENZYME SYSTEMS IN RAT LIVER AND HEART MITOCHONDRIA. Dement'eva, T. A.; Dokshina, G. A.; Pegel, V. A. (Tomsk State Univ., USSR). Translated from Radiobiologiya; 11: No. 5, 760-5 (Sep-Oct 1971).

The effects of betatron x radiation (25 MeV) and cobalt-60 γ rays at 1000 rad on cytochrome oxidase, succinic dehydrogenase, and catalase activities and on the content of SH-groups in the mitochondria and hyaloplasm of rat liver and heart 10, 30 min, 1, 2, 4, 6, 24, 48, and 72 hrs after irradiation were studied. The activity of the enzymes and thiol level of the mitochondria in rat heart and liver were found to change after irradiation, but with less effect after high energy irradiation. (tr-auth)

38679 (AEC-tr-7306, pp 187-9) CAPACITY OF RAT STEM CELLS TO FORM HEMATOPOIETIC COLONIES IN THE SPLEEN OF LETHALLY IRRADIATED MICE. Koval'chuk, L. V.; Khaitov, R. M. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 765-6 (Sep-Oct 1971).

The chromosome label method was used to demonstrate the capacity of rat stem cells to form colonies in the spleen of lethally irradiated mice. The genotype of these colonies is described. Simultaneous transplantation of xenogeneic bone marrow cells with lymph node cells syngeneic to the recipient completely inhibited the colony-forming capacity of rat stem cells. (tr-auth)

38680 (AEC-tr-7306, pp 190-5) REPOPULATION OF BONE MARROW CELLS IN MOUSE RECIPIENTS OF DIFFERENT LINES AFTER COMBINED TRANSPLANTATION FROM THREE GENETICALLY DIFFERENT DONORS. Khaitov, R. M. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 767-71 (Sep-Oct 1971).

The repopulation of radiation chimeras by cells in a bone marrow pool obtained from donors of different genotypes was studied. For this purpose, bone marrow cells from adult donors of three incompatible genotypes (A/HeJ, CBAT6T6, and (CBAT6T6 × C57BL)F$_1$) were transplanted separately or in a mixture to lethally irradiated CBA, C3H, or (CBA × C57BL)F$_1$ mice. With the help of cytogenetic analysis using chromosome markers, it was found that the combined transplantation of genetically different immunologically active cells to lethally irradiated recipients may result in inhibition or complete blocking of the multiplication of stem elements from some donors used to prepare the cell mixtures. (tr-auth)

38681 (AEC-tr-7306, pp 202-7) EFFECT OF SCREENING SOME PARTS OF THE BODY ON THE SURVIVAL TIME OF IRRADIATED RATS. Kashirin, V. S. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 775-8 (Sep-Oct 1971).

Dose-effect relationships, calculated LD$_{50/30}$ values, and indices of decrease in biological effect in cases of subtotal irradiation are presented. Screening a part of the rat body at the time of irradiation decreased substantially the biological effect of x irradiation; the protective effect was greatest when the upper half of the abdomen was screened. Protecting parts of the abdomen prevented the gastrointestinal syndrome from developing. When other parts of the body were screened, the clinical symptoms of the lesions were similar to those observed after whole-body irradiation. Only the size of the doses which caused equal mortality increased and the life-span of the animals was prolonged. (tr-auth)

38682 (AEC-tr-7306, pp 208-11) RADIOPROTECTIVE PROPERTIES OF INDOLYL ALKYLAMINOETHANOLS. Vasin, M. V.; Antipov, V. V.; Suvorov, N. N.; Preobrazhenskaya, M. N.; Orlova, L. M. Translated from Radiobiologiya; 11: No. 5, 779-81 (Sep-Oct 1971).

Experiments on mice showed that the indole analog of epinephrine (1-(indolyl-3')-2-methylaminoethanol-1 adipinate) has pronounced antiradiation properties. Substitution of an ethyl radical for the methyl in the amino group of this compound caused the substance to lose its antiradiation properties. Neither indole analogs of isadrine and ephedrine nor indolyl alkylamino alcohols containing a third amino group proved to be effective. (tr-auth)

38683 (AEC-tr-7306, pp 212-15) PROBLEMS OF DOSIMETRY IN CHRONIC IRRADIATION. Akatov, Yu. A.; Ilyukhim, A. V.; Popov, V. I.; Turkin, V. N.; Shafirkin, A. V.; Yurgov, V. V. Translated from Radiobiologiya; 11: No. 5, 781-4 (Sep-Oct 1971).

Some problems of individual dosimetry in chronic irradiation in radiobiological experiments are examined and the possibility of using dosimeters made of thermoluminescent glass (TLG) for this purpose is discussed. The results of measuring doses with such instruments in long-term radiobiological experiments on dogs are summarized. The data on individual dosimetry are consistent with the results of measuring dose fields by the ionization method. (tr-auth)

38684 (AEC-tr-7306, pp 216-21) CHANGE IN EFFECTIVE DOSES AND RESIDUAL INJURY AFTER PROTRACTED IRRADIATION OF MICE. Tikhomirova, L. S. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 784-8 (Sep-Oct 1971).

The method of double irradiation was used to study the change in the effective dose during four-day irradiation of mice at a constant dose rate and with residual injury 7, 10, 14, and 21 days after extended irradiation. The size of the effective dose was measured at the time irradiation was halted (278 R instead of 520 R). The radiosensitivity of the animals after extended irradiation decreased after 7, 10, and 21 days, compared with radiosensitivity at the time irradiation was halted. On day 14, hyperresistance was exhibited by the protractedly irradiated animals. (tr-auth)

38685 (AEC-tr-7306, pp 222-7) COMPARISON OF THE EFFECTS OF BRIEF AND PROLONGED IRRADIATION: FROM THE SURVIVAL RATE AND NUMBER OF NUCLEATED BONE MARROW CELLS OF MICE. Chertkov, K. S.; Busygin, V. E.; Khramchenkova, S. P. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 788-91 (Sep-Oct 1971).

Prolonged irradiation at a low dose rate (0.28 R/min) increased the LD$_{50/30}$ 1.36 times and the percentage of mice that died 4 to 5 weeks later more than did brief irradiation at a high dose rate (about 600 R/min). An exponential relationship was found between the number of nucleated bone marrow cells and irradiation dose after irradiation at both high and low dose rates. The ratio of equally effective doses with respect to number of nucleated cells was 2.1. Boundary values of the dose rate dividing brief from prolonged irradiation were determined in the range of 1 to 5 R/min. (tr-auth)

38686 (COO-1602-29) CHANGES IN CATALASE ACTIVITY IN RAT TESTICULAR PREPARATIONS INDUCED BY HYPOPHYSECTOMY AND X-IRRADIATION. Buhrley, Louis E.; Ellis, LeGrande C. (Utah State Univ., Logan). [1972]. 22p. Dep. NTIS.

Catalase activity was measured in rat testes from control, hypophysectomized, and x-irradiated rats (150 R) with standard manometric techniques. A comparison was made in the enzyme activity from minced testicular preparations and teased-tubular preparations for all groups of animals. Catalase activity was greater for all of the minced preparations than it was for the teased-tubular preparations, as was previously observed in this laboratory for steroid biotransformations. Hypophysectomy markedly reduced total catalase activity of rat testicular tissue when expressed on a per animal basis, but it was increased by hypophysectomy on a per tissue basis due to a loss of germinal element of the testes. On this basis, the enzyme was assumed to be preferentially located in a more stable cell type in the seminiferous tubule which was not as severely affected by the withdrawal of gonadotropins (i.e., nongerminal cells). Irradiation increased catalase activity from 4–31 days, but decreased it from 35 through 50 days post-treatment, indicative of a physiological role of this enzyme for the testes. (auth)

38687 (COO–2000-84) LOW-LEVEL X-IRRADIATION OF THE BRAIN DURING DEVELOPMENT: MORPHOLOGICAL, PHYSIOLOGICAL AND BEHAVIORAL CONSEQUENCES. Annual Progress Report, September 1, 1971–August 31, 1972. Altman, Joseph (Purdue Univ., Lafayette, Ind.). 1972. Contract AT(11-1)-2000. 12p. Dep. NTIS.

The effect of different schedules of x irradiation on the development of the cerebellar cortex was studied in rats following exposure of the head only to repeated doses commencing at birth, at day 4 after birth, and at day 3, 4, or 6 after birth. Profound alterations occurred in the morphological organization of the cerebellar cortex in all cases following exposure, but the changes were drastic when the irradiation schedule was such that the regeneration of the external germinal layer was prevented. The behavioral consequences of cerebellar irradiation during infancy on the development of motor capacity in young rats were studied. Irradiation schedules that led to a reduction of cerebellar interneurons resulted in a pronounced incoordination of the hindlimbs. The effect of infantile cerebellar irradiation on motor performance during the aging process in rats was also studied. The results suggested an interaction between senescence and the irradiation treatment. The effects of x irradiation on the postnatal development of the cerebellar cortex in rats were compared with the effects of hyperthyroidism, hypothyroidism, and malnutrition. Both hyper- and hypothyroidism caused a reduction in the number of synapses in the molecular layer of the cortex. Postnatal malnutrition led to a reduction in the number of cerebellar microneurons and a significant decrease in the area occupied by the molecular and granular layers of the cerebellum. (E.R.B.)

38688 (COO–3013-9) RADIATION EFFECTS ON RAPIDLY AND SLOWLY PROLIFERATING CELL RENEWAL SYSTEMS. Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(30-1)-4244. 31p. (CONF-700980–1). Dep. NTIS.

From fifth symposium on cancer; San Francisco, CA. (Sep 1970).

A review is presented of the effects of radiation on cell population kinetics of proliferating cell renewal systems. Effects of protracted and fractionated irradiation on regenerative capacities of tissues are emphasized. In a discussion of the radiosensitivity of the cell renewal system of the mammalian intestinal mucosa, it is pointed out that cell depletion and repopulation are rapid events under conditions which disturb the integrity of the dynamic balance. A review of radiation effects on bone marrow and related hematopoietic tissues includes discussions of interspecies variation, effects of acute and continuous irradiation, and effects of erythropoietin. A review of radiation effects on seminiferous epithelium includes discussions of homeostatic control of cell proliferation and radiation effects on sperm production and fertility. It is concluded that the small intestine has the highest tolerance to protracted radiation exposure, the testis the lowest, and hemopoietic tissues are intermediate between the two. (H.L.W.)

38689 (COO–3013-14) SPERMATOGONIAL CELL RENEWAL. Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(30-1)-4244. 16p. (CONF-710508–4). Dep. NTIS.

From nineteenth annual meeting of the Radiation Research Society; Boston, Mass. (9 May 1971).

Histological studies on the kinetics of spermatogonial cell renewal in mice and rats are summarized. These studies provide insight to the premeiotic stages of spermatogenesis in higher mammals, particularly man. The dynamic structure of cell populations and the sequence of differentiation are discussed and models of spermatogonial stem cell renewal are described. Studies using radiation showed that under continuous low dose rates cell renewal during spermatogenesis in mice achieved a near-steady state of cell population for at least 12 cycles of spermatogonial cell renewal and three cycles of the seminiferous epithelium. There was a slight differential radiosensitivity among the different types of spermatogonial cells. At dose rates greater than two rads per day, spermatogonia are very sensitive to radiation death. After acute exposure a minimum number of surviving stem cells is required to repopulate the functional seminiferous epithelium, regeneration proceeds along an ordered cell stage sequence, and is dependent on the time required for all stages of spermatogonia to become mature spermatozoa. (H.L.W.)

38690 (COO–3013-16) CELL POPULATION KINETICS IN THE SEMINIFEROUS EPITHELIUM UNDER CONTINUOUS LOW DOSE RATE IRRADIATION. Fabrikant, Jacob I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(30-1)-4244. 5p. (CONF-710545–1). Dep. NTIS.

From nineteenth annual meeting of the Association of University Radiologists; Durham, NC. (11 May 1971).

The present studies indicate that although the seminiferous epithelium may be able to maintain function and cell population at a reduced level under continuous exposure for prolonged periods at about 1.8 rads per day, it appears that there is only limited capacity to change the patterns of cellular proliferation while still remaining under homeostatic control. As yet, there is no information on the possible production of genetic damage, such as chromosome aberrations, in spermatogonia affecting proliferation under low dose-rate exposure. The extent to which this affects the regenerative capacity under continuous irradiation would be valuable information. Certain of the renewal systems can increase cell proliferation rates and the size of proliferative zones to compensate for cellular radiation damage at relatively high dose rates. It is now becoming apparent that even at dose rates of less than 2 rads per day, spermatogonia may be very sensitive to radiation death, and that the main reason for this low tolerance to continuous irradiation may very well be the lack of compensatory mechanisms regulating spermatogonial cell reproduction. (auth)

38691 (COO–3013-30) CELL POPULATION KINETICS IN THE SEMINIFEROUS EPITHELIUM UNDER CONTINUOUS LOW DOSE RATE IRRADIATION. Fabrikant, Jacob I. (Johns Hopkins Univ., Baltimore, Md. Dept. of Radiological Sciences). [1967]. Contract AT(30-1)-3970. 10p. Dep. NTIS.

Cellular response and cell population kinetics in the seminiferous epithelium during spermatogenesis were studied in 6-week-old C57BL mice exposed to continuous whole-body ^{137}Cs γ irradiation at a dose rate of 1.8 rads/day for up to 15 weeks. The extent to which the spermatogonial cell population accumulated damage under continuous low dose rate exposure affecting cell proliferation and thus the speed and efficiency of regeneration was determined. (E.R.B.)

38692 (COO–3013-34) LYMPHOID CELL RENEWAL UNDER LOW LEVEL IRRADIATION. XI. CELL CYCLE AND GROWTH KINETICS DURING RADIATION LEUKEMOGENESIS IN C57BL MICE. Fabrikant, Jacob I.; Foster, Bessie R. (Connecticut Univ., Farmington. Dept. of Radiology). [1970]. Contract AT-(11-1)-3013. 10p. (CONF-711141–2). Dep. NTIS.

From fifty-seventh annual meeting of the Radiological Society of North America; Chicago, IL. (28 Nov 1971).

Mice were given 200 rads of whole-body x radiation four times at intervals of seven days. Observations were made on weight changes in the thymus and cell population kinetics for a period of 25 weeks after the first irradiation. The weights of irradiated thymuses remained less than those of controls for eleven weeks, then reached normal, and thereafter became greater than controls. This was associated with the development of thymic lymphoma and disseminated leukemia developed in more than half the irradiated mice. The median durations of the thymus lymphoid cell cycle are tabulated. The cycles were shortened in the irradiated mice and it appeared that thymic leukemogenesis was associated with the progressive breakdown of cellular control mechanisms. (H.L.W.)

38693 (COO–3097-4) INTERRELATIONSHIP OF ERYTHROPOIETIC RECOVERY, MARROW RECOVERY, COLONY FORMING UNITS, AND ERYTHROPOIETIC STIMULATING FACTORS FOLLOWING SUBLETHAL X-IRRADIATION. OKunewick, James P.; Fulton, Doris; Markoe, Arnold M.; Phillips, Eleanore L. (Allegheny General Hospital, Pittsburgh, Pa. (USA). Cell and Radiation Biology Labs.). [1972]. Contract AT(11-1)-3097. 35p. Dep. NTIS.

Studies were performed to compare the injury and recovery of various elements of the erythropoietic system in rats following sub-lethal (200 R) exposure to x rays. In the peripheral blood, a distinct fall and an early (6 to 7 day) abortive rise in reticulocytes and newly formed hemoglobin could be seen, followed by a second drop and final recovery to normal levels at 2 to 3 weeks after exposure. A similar drop in total nucleated cells could be seen in both femoral marrow and spleen. However, splenic recovery was slow, whereas recovery to normal nucleated cell levels occurred by 5 days in the marrow. Transplantable marrow colony forming units also showed delayed recovery reaching normal proportions at 16 days with no abortive rise. Total blood and plasma volumes showed only minimal changes, although there was a significant drop in hematocrit. Levels of erythropoietic stimulating factors (E.S.F.) showed a slight increase consistent with the fall in hematocrit but no large fluctuations that could be easily correlated with the variations in reticulocyte production. The data was compared with other published data for post-irradiation changes in the E.S.F. responsive compartment and some possible causes for the variations in post-irradiation erythropoiesis are discussed. (auth)

38694 (COO-3264-2) INBORN ANEMIAS IN MICE. Progress Report, May 1, 1971–April 30, 1972. Russell, Elizabeth S.; Bernstein, Seldon E. (Jackson Lab., Bar Harbor, Maine). 1 May 1972. Contract AT(11-1)-3264. 16p. Dep. NTIS.

Mice of three different genotypes were used in studies on radiosensitivity of erythroid stem cells and their erythroid microenvironments. After whole-body x irradiation of mutant mice, the spleens were removed and transplanted to non-irradiated anemic recipients; an improvement in the hematological condition of the recipient mice was observed. A table is presented to show the numbers and kinds of animals employed, the radiation doses used, the variations in time elapsed between irradiation of the donor and implantation of the graft, and an estimation of the LD$_{50}$. Progress is also reported on transplantation of mouse bone marrow cells between mice of different genotypes; analysis of hemopoietic defect of steel anemic mice extrinsic to stem cells; plasma erythropoietin levels in stressed anemic mice; metabolic characteristics of mutant erythrocytes; pyrrole pigments in normal and congenitally anemic mice; iron distribution and metabolism in mice with microcytic anemia; establishment and study of sex-linked anemia; preparation of improved stock carrying Hertwig's anemia; and characterization of NZB/B1J mice at the Jackson Laboratory. (H.L.W.)

38695 (LA-4923) ANNUAL REPORT OF THE BIOLOGICAL AND MEDICAL RESEARCH GROUP (H-4) OF THE LASL HEALTH DIVISION, JANUARY THROUGH DECEMBER 1971. Richmond, C. R.; Voelz, G. L. (Los Alamos Scientific Lab., N. Mex.). Apr 1972. Contract W-7405-eng-36. 153p. Dep. NTIS.

Research activities of the Los Alamos Scientific Laboratory's Biomedical Research Group for the calendar year 1971 are summarized. Projects under investigation in the following major areas of research are reported: the preparation of ^{238}PuO$_2$ microspheres for use in inhalation studies in mammals; molecular radiobiology, with emphasis on the effects of x irradiation on genetic information transfer processes in Escherichia coli; cellular radiobiology, with emphasis on the effects of x irradiation on regulatory and control mechanisms in the mammalian cell cycle; mammalian radiobiology, with emphasis on the effects of low dose rate whole-body γ exposure on dogs, monkeys, and mice; and mammalian metabolism, with emphasis on the uptake and retention of ^{203}Hg, ^{110}Ag, and ^{75}Se in mice and rats, and the content of ^{137}Cs in the human population of New Mexico during 1970 and 1971. An appendix containing a bibliography of published papers, major symposia and seminars sponsored, and a list of papers presented at seminars and meetings during 1971 for each section in the Biomedical Research Group is included. (E.R.B.)

38696 POPULATION GENETICS OF LEBISTES (POECILIA) RETICULATUS PETERS (POECILIIDAE, PISCES). I. EFFECTS OF RADIATION-INDUCED MUTATIONS ON THE SEGREGATION RATIO IN POSTIRRADIATION F$_2$. Schroeder, Johannes Horst; Holzberg, Sebastian (Association for Radiation and Environmental Research, Neuherberg, Ger.). Genetics; 70: No. 4, 621-30(Apr 1972).

Wild-type germ cells of the viviparous fish, Lebistes (Poecilia) reticulatus, were irradiated in the stages of oogonia, spermatogonia or spermatozoa with 1000 R of x rays at a dose-rate of 200–220 R/min. The grown-up fish were mated after irradiation or sham treatment to unirradiated mutant fish homozygous for three recessive gene loci, causing albinism, lack of yellow and reddish pigmentation ("blue" constitution), and diminution of the size of melanophores ("blond" constitution). As compared to the control series, the phenotypic segregation ratios in the adult F$_2$ generation after irradiation was changed significantly in favor of wild-type and blue fish, whereas the proportion of albinotic, blond and "white" (= blond + blue) guppies was lowered. This unidirectional effect in postirradiation F$_2$ was greatest after exposure of spermatozoa with 2 × 500 R (24 hr apart), followed by single doses of 1000 R to spermatogonia and oogonia. These results were explained in terms of a synergistic interaction of recessive radiation-induced mutations in the heterozygous state with those genotypes of the guppy which affect the formation of melanophoric patterns and the synthesis of melanins. (auth)

38697 DOSE-RATE EFFECTS ON RBE OF CALIFORNIUM AND RADIUM REACTIONS OF PIG SKIN. Atkins, Harold L.; Fairchild, Ralph G.; Robertson, James S. (Brookhaven National Lab., Upton, N. Y.). Radiology; 103: No. 2, 439-42(May 1972).

Experiments on the skin of swine showed a marked dose-rate dependence of the biological effect of cesium-137 or radium-226 gamma rays from contact sources over the clinically useful range. The slope of a line relating duration of exposure to dose was 0.296 in a series of experiments. On the other hand, exposure to mixed neutron and gamma-ray ^{252}Cf radiation resulted in effects which were much less dependent on dose rate. The relative biological effect varied markedly with dose rate from about 5 at acute exposures to over 7 at prolonged low-dose-rate exposures. (auth)

38698 EFFECT OF FRACTIONATION OF RADIATION DOSE ON SKIN CONTRACTION AND SKIN REACTION OF SWISS MICE. Hayashi, Shigejiro; Suit, Herman D. (Univ. of Texas, Houston. Anderson Hospital and Tumor Inst., Houston, Tex.). Radiology; 103: No. 2, 431-7(May 1972).

After doses of 1,200 to 3,500 rads x radiation, skin contraction in female Swiss albino mice develops rapidly, reaches a maximum between 15 and 27 days, then promptly relaxes and remains essentially stable from day 60 to day 180. With dose fractionation, approximately 60 to 70% of damage due to D$_1$ for 2-fraction irradiation and 70 to 100% damage due to D$_{1-9}$ for 10-fraction irradiation was repaired by time of final or test dose. Effect of dose fractionation on acute skin reaction and on epilation was approximately the same as for skin contraction. Contraction was not dependent upon development of a moist reaction. (auth)

38699 STUDIES ON THE INDUCTION OF TRANSLOCATIONS IN MOUSE SPERMATOGONIA. V. EFFECTS OF SHORT-TERM FRACTIONATION. Searle, A. G.; Beechey, C. V.; Evans, E. P.; Ford, C. E. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 15: No. 2, 169-74(Jun 1972).

Translocation frequencies were studied in spermatocytes derived from the spermatogonia of mice given 300 rad x-rays in two equal fractions separated by intervals of 0–8 h. In the first experiment (0–2 h intervals) there was a significant fall from 14.5% to 8.1% in the frequency of affected cells when there was an 0.5-h interval between doses instead of a single dose, followed by a just significant rise to 10.8% at a 2-h interval. However, the translocation frequency after a single 300-rad dose was higher than expected from previous experiments at this level (see paper III of this series). In the second experiment (0–8 h intervals) there was again an initial fall (from 8.8% at 0 h to 6.6% at 1 h) and a rise later (to 8.1% at 6 h and at 8 h intervals), but the changes in frequency did not reach a significant level. Results are compared with those obtained in similar recent experiments by Léonard and Deknudt (500 R total exposure) in which an initial decrease in yield was also found, but with more pronounced fluctuations in frequency later. The relative importance of radiation-induced changes in the spermatogonial population and of decreased opportunities for interaction of lesions on fractionation is discussed with reference to the observed effects. (auth)

38700 MUTAGENIC EFFECTS OF REPEATED SMALL RADIATION DOSES TO MOUSE SPERMATOGONIA. I. SPECIFIC-LOCUS MUTATION RATES. Lyon, Mary F.; Phillips, Rita J. S.; Bailey, Heather J. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 15: No. 2, 185-90(Jun 1972).

When male mice were given repeated small daily doses of 10 rad γ-rays at high dose rate (17 rad/min) the yield of specific-locus mutations was less than when the same total dose (600 rad) was given in a single exposure, and about the same as that after irradiation at low dose rate (0.008 rad/min). However, when a similar total dose was split into doses of 50 rad at weekly intervals the results depended on dose rate. The mutation rate after 12 × 50 rad x-rays at 66–70 rad/min was not significantly different from that after a single exposure, whereas the mutation rate after 12 × 50 rad γ-rays at 0.06 rad/min was typical of low dose-rate irradiation. This confirms that the effect of dose rate on mutation rate does not depend on continuity or close spacing of the exposures. However, it is suggested that the small dose effect depends both on size of each dose and on close spacing of doses. (auth)

38701 ELECTRON MICROSCOPICAL EXAMINATION OF THE IMMATURE AND MATURE PLACENTA OF RATS AFTER A WHOLE-BODY IRRADIATION OF 400 R. Franke, H.; Rasch, R.; Goetze, E. (Institut fuer Pathologische Physiologie, Jena, Ger.). Radiobiol.-Radiother.; 13: No. 1, 65-75(1972). (In German).

The reaction of the immature and mature rat placenta exposed to a total body irradiation of 400 R was examined using electron microscopy. The immature placenta is much more radiosensitive than the mature one because the differentiation of the fetal capillaries is not complete in many cases at the period of radiation. Inhibition of mitosis and injury of allantoic cells cause an irreparable loss of fetal blood vessels. The placental microcirculation of the fetus is disturbed. From the trophoblastic layers only the internal syncytium, directly bordering on the fetal blood vessels, shows prominent alterations of the fine structure. (auth)

38702 DEMONSTRATION OF RADIATION INJURIES IN THE RETICULOENDOTHELIAL SYSTEM OF THE MOUSE BY MEANS OF PHAGOCYTOSIS STIMULANTS. Nothdurft, W.; Flemming, K. (Univ., Freiburg i. B.). Radiobiol.-Radiother.; 13: No. 1, 77-92(1972). (In German).

The RE phagocytic activity of young adult male mice established by means of the intravascular clearance of 16 mg carbon per 100 g body weight was not significantly altered in the first 2 days following whole-body x-irradiation. The doses used were 560 R (LD $5/_{30d}$), 750 R_0(LD $85/_{30d}$) and 1500 R. However, it had been concluded from a slight depression established in previous studies by higher doses of a carbon suspension that the metabolic reactivity of the macrophages was disturbed by irradiation even at a sublethal level. To test this assumption four different RE stimulants that mainly affected the activity of the single cells without causing proliferation were administered 30 minutes after irradiation, and their phagocytosis stimulating properties were evaluated at the time of maximum efficiency. The substances used were polyvinyl-pyridine-N-oxide (PVNO), lipopolysaccharide Pyrexal, emulsified olive oil and triolein. They all were injected intravenously and the phagocytic activity was evaluated by the clearance rate of 16 mg carbon per 100 g body weight. The phagocytic indices K of the non-irradiated mice were elevated up to 190% of the control level by PVNO, 420% by Pyrexal and 230% and 310% by olive oil and triolein resp. The stimulatory ability of olive oil and triolein was already significantly reduced after 560 R (LD $5/_{30d}$) and was fully depressed in the 1500 R groups. In contrast, the excellent stimulation produced by the lipopolysaccharid Pyrexal was not reduced by 750 R pre-irradiation (LD $85/_{30d}$). A slight but significant reduction of the K value was observed in the 1500 R group. But the remaining hyperactivity was very high when compared to olive oil and triolein. The only substance the phagocytosis stimulating efficiency of which was not significantly affected by either 750 R or 1500 R was PVNO. The interaction of the preceding irradiation with the mechanism of action of the different RE stimulants is discussed on the basis of the different types of dose-effect relationship. (auth)

38703 ANIMAL EXPERIMENTAL EXAMINATIONS FOR THE JUDGEMENT OF THE REACTIVITY OF THE HEMATOPOIETIC SYSTEM AFTER CYTOSTATIC TESTING BY MEANS OF THE ADRENALIN AND PYRASIDE TEST. Schmidt, W.; Morczek, A.; Wichert, H. (Medizinische Akademie, Magdeburg, Ger.). Radiobiol.-Radiother.; 13: No. 1, 93-103(1972). (In German).

For judging hematopoietic functioning following irradiation or cyclophosphamide application in 132 rats the adrenal and pyraside tests were employed. Both tests were effective for determining the impairment of hematopoiesis by various doses of radiation and cyclophosphamide. Due to the absence of side effects the adrenalin test is recommended for judging bone marrow functioning in clinical practice. (H.L.W.)

38704 RADIORESISTANCE OF ANIMALS WITH THE INJECTION OF POLYSACCHARIDES FROM O-SOMATIC ANTIGENS OF INTESTINAL BACTERIA. Duplishcheva, A. P.; Sinilova, N. G.; Ivanov, K. K. Radiobiol.-Radiother.; 13: No. 1, 113-22 (1972). (In German).

Polysaccharides which were obtained from O-somatic antigens of intestinal bacteria have radioprotective properties if they are given once in non-toxic doses 24 hours before irradiation. The protective effect was found in different animals (mice, rats, rabbits) irradiated with medium lethal doses and the minimum absolute lethal dose of γ radiation. The preparations are most effectively given to mice and rats by intraperitoneal and subcutaneous injection and to rabbits by intravenous injection. (auth)

38705 REPAIR OF RADIATION DAMAGE TO RAT THYROID CELLS IN VIVO: A HIGHLY-DIFFERENTIATED SYSTEM. Malone, J. F. (Western Regional Hospital Board, Glasgow); Hooper, L. A.; Orr, J. S.; Greig, W. R. Int. J. Radiat. Biol.; 21: No. 5, 503-10(May 1972).

The adult rat thyroid is established as a system in which mitotic activity is minimal. Recovery from γ radiation damage is demonstrated in thyroid cells in vivo using split-dose recovery curves and a fractionated-dose survival curve over a dose range 0 to 1500 Rads. It is suggested that the results are relevant to radiotherapy and possibly to the theory of recovery. (UK)

38706 MUTAGENIC EFFECTS OF REPEATED SMALL RADIATION DOSES TO MOUSE SPERMATOGONIA. II. TRANSLOCATION YIELD AT VARIOUS DOSE INTERVALS. Lyon, Mary F.; Phillips, Rita J. S.; Glenister, P. H. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 15: No. 2, 191-5(Jun 1972).

Male mice were given repeated doses of 12 × 50 rad x-rays at high dose-rate at either daily or weekly intervals, and the yields of translocations in spermatocytes irradiated as spermatogonia were compared with those after a single exposure to 630 rad γ-rays. The yield after either type of repeated dose was significantly lower than that after a single exposure, and the two repeated dose regimes did not differ significantly from each other. The results thus appear to suggest that size of each dose rather than interval between doses is important in determining the effect of repeated radiation doses, but this interpretation is probably too simple and further work is needed. (auth)

38707 EFFECT OF X-RADIATION ON THE SURVIVAL OF SKIN FLAPS IN THE PIG. Patterson, T. J. S.; Berry, R. J.; Wiernik, G. (Churchill Hospital Research Inst., Oxford). Brit. J. Plast. Surg.; 25: 17-19(Jan 1972).

Preliminary results of studies on the short-term radiation effects on pig skin are discussed. Assessment was by means of a skin flap preparation on the flank of the pig. A rectangular flap of skin was raised in such a way that all blood supply was divided, except that coming in from a ventrally sited pedicle. The efficiency of this blood supply was then measured by the length of the flap that survived. Alterations in the blood supply as a result of radiation to a flap should thus be shown by alterations in the surviving length of the flap. (auth)

38708 CELLS INVOLVED IN THE IMMUNE RESPONSE. XXIII. THE DEMONSTRATION OF TWO CO-EXISTING CELL-PATHWAY SYSTEMS FOR THE INDUCTION OF THE PRIMARY HUMORAL IMMUNE RESPONSE IN OUTBRED ADULT RABBITS. Haasz, R.; Richter, M. (McGill Univ., Montreal). Pathol. Microbiol.; 37: 425-35(1971).

Normal outbred adult rabbits obtained from the same breeder at different times and from different breeders at the same time display a difference in their capacity to give a primary humoral immune response with respect to conventional antigens. This variation in response is characterized by marked differences, both in terms of sensitivity to the amount of antigen injected, and in terms of the resistance or susceptibility of the response to whole-body irradiation. Thus, the humoral immune response may ensue through the participation of both the antigen-reactive cell and antibody-forming cell or through the mediation of the antibody-forming cell only. These 2 cell pathways can be differentiated on the basis of their sensitivity to irradiation. (auth)

38709 HISTOMETRIC EVALUATION OF PERIODONTAL BONE LOSS IN RATS. I. THE EFFECT OF MARGINAL IRRITATION, SYSTEMIC IRRADIATION, AND TRAUMA FROM OCCLUSION. Carranza, F. A. Jr.; Simes, R. J.; Mayo, J.; Cabrini, R. L. (Univ., Buenos Aires. Comision Nacional de Energia Atomica, Buenos Aires). J. Periodontal Res.; 6: 65-72(1971).

The effect of marginal irritation, trauma from occlusion, and whole-body x irradiation on interradicular bone of Wistar rat molars was studied after an experimental period of two weeks. Histologic findings and statistical evaluation of histometric results indicate that: the only single factor capable of reducing the height of interradicular bone was marginal irritation; the only additional factor that was capable of increasing this reduction in height was whole-body x irradiation; marginal irritation, either alone or in combination with trauma from occlusion, increased bone density in the submarginal area; whole-body x irradiation inhibited the osteogenic reaction induced in the submarginal area by marginal irritation; and trauma from occlusion did not have any effect on the parameters measured. (auth)

38710 ELEMENTAL DIET IN THE MANAGEMENT OF THE INTESTINAL LESIONS PRODUCED BY RADIATION IN THE MOUSE. Hugon, J. S.; Bounous, G. (Univ. of Sherbrooke, Quebec). Can. J. Surg.; 15: 18-26(Jan 1972).

An elemental diet containing amino acids instead of proteins improved significantly the 30-day survival of mice following whole-body exposure to 900 rads of γ rays. The elemental diet also produced significant benefit in the intestinal mucosa. The initial radiation damage in the intestinal crypts was unaffected by the dietary regimen, but the elemental diet led to a faster recovery from such lesions and the mitotic index was higher in these animals. In the absorbing cells of the villi, the initial lesion was lessened by the elemental diet and the repair process was greatly facilitated. Presumably, irradiation impairs the ability of the intestinal mucosa to perform terminal digestion of protein; hence ingestion of amino acids is beneficial because such terminal digestion is no longer necessary. (auth)

38711 BASIC MECHANISMS OF RADIATION INJURY AND REPAIR IN MAMMALIAN SYSTEMS. Pradhan, D. S.; Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay). J. Sci. Eng. Res. (India); 30: 703-15(Dec 1971).

Metabolic alterations arise, to varying degrees, from exposure of animals to ionizing radiations which, depending on the dose received, could cause haemorrhage, increased susceptibility to infection, cancer, heritable changes, or death. Most of these derangements are derived basically from disturbances in cellular kinetics. Thus, parts of the body in which there is active cell renewal, such as the haemopoietic system and the gastrointestinal tract are more radiosensitive than those in which there is slow cell replacement, such as liver, kidney, and muscle. While mammalian cells in culture are inactivated at a high dose range, mainly due to damage to DNA, comparatively small doses can affect cell turnover in radiosensitive organs, which would indicate that there could be other primary radiolesions also. Inhibition of DNA synthesis, changes in protein synthetic patterns, uncoupling of oxidative phosphorylation, release of lysosomal enzymes, impairment in gastrointestinal functions, increased urinary excretion of amines, and fat infiltration have been found to be some of the early biochemical effects of radioexposure. It is not known as yet whether these effects reflect disturbances in regulatory mechanisms or constitute compensatory processes. Nevertheless, probes into the factors underlying these perturbations have unravelled some interesting biochemical controls. This review covers various studies pertaining to these areas of radiobiological research and attempts to provide an integrated picture of the stepwise development of radiation injury and the opposing mechanisms which either correct or bypass radiation-induced lesions. (auth)

38712 EFFECT OF IONIZING RADIATION UPON PROTEIN-SYNTHESIZING SYSTEMS (SYNTHESIS OF MILK PROTEINS IN THE LACTATING MAMMARY GLAND). Ivanov, I. I.; Rudakov, V. V. (Inst. of Experimental Medicine, Leningrad). Dokl. Akad. Nauk SSSR; 201: No. 3, 731-2(21 Nov 1971). (In Russian).

Experiments were conducted with lactating white rats by administering ^{14}C-labeled glycine before irradiation. Incorporation of the ^{14}C-glycine into water-soluble proteins in the mammary gland five hr after a 5,000 R dose of γ radiation was practically no different from protein synthesis in the non-irradiated animal. A few days later the irradiated rats incorporated one-half to one-third as much of the labeled compound into the milk protein, even at greatly reduced (600 R) doses. A dose of 1,200 R nearly terminated the production of the labeled protein four days after irradiation. (K.S.W.)

38713 COEFFICIENTS OF MUTUAL CORRELATION OF ELECTROENCEPHALOGRAMS IN IRRADIATED RABBITS. Anan'ev, V. M.; Vlasova, N. I.; Nazarov, V. A.; Soboleva, K. V.; Stefashkin, Yu. P. (Inst. of Biophysics, Moscow). Byull. Eksp. Biol. Med.; 73: No. 3, 51-3(Mar 1972). (In Russian).

Coefficients of mutual correlation of electroencephalograms (EEG), in combination with their other indices (frequency, amplitude), serve as a sensitive indicator of the changes in functional condition of cerebral cortex and definitely reflect the character of a system of mutual relations of cortical electrical activity at the points of EEG leads. It is recommended to use a generalized index of EEG correlation to assess the severity of cortical damage and the extent of restoration of the initial condition of the cortex. (auth)

38714 INCIDENCE OF DELAYED MORTALITY (SECONDARY DISEASE) IN ALLOGENEIC RADIATION CHIMERAS RECEIVING BONE MARROW FROM AGED MICE. Chen, M. G.; Price, G. B.; Makinodan, T. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Oak Ridge). J. Immunol.; 108: No. 5, 1370-8(May 1972).

The effect of donor age on the reactivity of bone marrow from a long-lived hybrid mouse in the pathogenesis of secondary disease in young, lethally irradiated, allogeneic recipient mice was studied. The influence of the thymus on potential effector cells in the bone marrow was also examined in marrow donors and in allogeneic recipients. In contrast to the marked reduction in the humoral immune response with senescence in this hybrid, the ability of bone marrow from old donors to precipitate secondary disease was more than equivalent to that of the corresponding tissue from young donors in both tempo and severity of reaction. Thymectomy of the donors at 2 months of age or a combination of adult thymectomy and sublethal irradiation did not diminish the severity of the disease; host thymectomy only temporarily retarded the course of the reaction but not the final cumulative mortality. The results are compatible with the existence of a large, long-lived, stable population of cells, reactive in initiating delayed mortality, which does not diminish appreciably with senescence. (auth)

38715 LATE PATHOMORPHOLOGICAL LESIONS IN THE OVARIES OF MICE IRRADIATED WITH GAMMA RADIATION (^{60}Co) ON THE FIRST DAY OF LIFE. Chomiczewski, K. (Military Medical Academy, Lodz, Poland); Gajewski, A. K. Folia Biol. (Krakow); 20: No. 1-2, 93-100(1972).

Female newborn mice of the inbred A strain were whole-body irradiated with 150 to 450 R of gamma radiation. After 400 days, changes in the ovaries of mice irradiated with 150 R consisted in atrophy of the ovary, inhibited ovulatory cycle, and proliferation of the cells of the membrana granulosa and theca cells. Doses of 300 and 450 R completely inhibited ovulation, causing sterility and the appearance of granulosa-cell and thecoma tumours. Pathomorphological evidence is adduced indicating a correlation between the disorders of the pituitary-ovarian axis and neoplasmatic proliferation of the cells of the granular layer and theca cells. (auth)

38716 LATE PATHOMORPHOLOGICAL CHANGES IN THE TESTES OF MICE IRRADIATED WITH GAMMA RADIATION (^{60}Co) ON THE FIRST DAY OF LIFE. Chomiczewski, K. (Military Medical Academy, Lodz, Poland). Folia Biol.; 20: No. 1-2, 101-10(1972).

Newborn male mice were whole-body irradiated with 150 to 450 R of gamma radiation. After 400 days changes in the testes were observed after each of the doses, consisting in diminished weight of the testis, diminished surface area of the seminiferous tubules, inhibited or markedly impaired spermatogenesis and spermiogenesis, and proliferation of the stróma and Leydig cells. The intensity of these changes was proportional to the dose of irradiation. The pathomorphological changes in the testes were not correlated with changes in the hypophysis. (auth)

38717 RADIOSENSITIZING EFFECT OF MECYTOSINE FROM THE TIME OF ITS INTRODUCTION AND FRACTIONATION OF THE IRRADIATION DOSE. Aleksandrov, S. N.; Vershinina, S. F. (Central Research Inst. of Roentgeno-Radiology, Leningrad). Med. Radiol.; 17: No. 5, 36-8(May 1972). (In Russian).

Experiments were conducted on 221 mongrel mice and 50 mice of the AKR line with ascitic and solid form of Erlich's tumor and the solid variant of sarcoma 37. The results point to a marked radiosensitizing effect with mecytosine introduced prior to irradiation which is thereafter applied in booster doses. (auth)

38718 DISTRIBUTION OF DOSES OF LOW-ENERGY X-RADIATION IN RADIATION DAMAGE OF THE SKIN. Sokolina, L. L.; Novikova, L. V.; Barabanova, A. V. Med. Radiol.; 17: No. 5, 39-43(May 1972). (In Russian).

The distribution of soft x-ray radiation in different structures of the skin was studied. The greatest part of the dose of low-energy radiation is absorbed in the epidermis and only an insignificant part penetrates into the deep-lying layers. This also, apparently, explains the absence of the pain syndrome and good restoration of the skin. (auth)

38719 STRAIN VARIATIONS IN THE INCIDENCE OF DOMINANT LETHALS INDUCED BY X-IRRADIATION GIVEN TO MOUSE SPERMATOZOA. Leonard, A.; Deknudt, Gh.; Linden, G.; Gilliavod, N. (CEN/SCK, Mol, Belgium). Strahlentherapie; 143: No. 1, 102-5(Jan 1972).

The rate of dominant lethal mutations induced in spermatozoa by x-irradiation was studied in RF, BALB/c, C3H, CBA, CO13, AKR/T1Ald, C57Bl and AKR strains of mice. Four-hundred R given to the males induce a slight reduction in the frequency of fertile matings in most of the strains. The dominant lethal mutation rate induced by 400 R decreases from 0.43 in the C57Bl strain to 0.13 in the RF strain. In most of the strains the increase of prenatal loss is the result of an increase of both pre- and post-implantation death. Comparison between the present data and results obtained with rat, guinea-pig and rabbit indicates that variation between different strains of mice with respect to the dominant lethals induced by x-irradiation given to spermatozoa is as large as that between mouse and the former species. Only hamster appears to be somewhat more radiosensitive. (auth)

38720 PARATHYROID DISEASES AND IRRADIATION. Berdjis, Charles C. (Armed Forces Inst. of Pathology, Washington, D. C.). Strahlentherapie; 143: No. 1, 48-62(Jan 1972).

Irradiation produces acute and delayed changes in parathyroid parenchyma. Doses ranging between 500 and 2,500R, including LD$_{50}$, have no immediate significant effects on the parathyroids. Massive doses (5,000 to 10,000R) are essentially harmful, and high dose rates are particularly destructive. Degeneration, necrosis, and foci of hemorrhage are often found with massive doses. Capillaries and small blood vessels show necrosis and/or hyalinization of their walls and degeneration, vacuolization, and rupture of the endothelial lining, with frequent microthrombi. In general, irradiation reduces the number of mitochondria in the oxyphil cells and increases the glycogen in the chief cells. Irradiation produces three major cytologic changes: increased number of oxyphils, shift of the chief cells toward the clear cells, and residual damage. These cytologic changes, together with metabolic disturbances and hormonal imbalance, pave the way for tumor formation (adenomas and carcinoma) and associated systemic diseases (of bone and kidney). (auth)

Invertebrates

38721 RADIOSENSITIVITY OF OOCYTES OF DROSOPHILA. I. SENSITIVITY OF CLASS-A OOCYTES OF TRIPLOID AND DIPLOID FEMALES. Wuergler, F. E.; Luetolf, H.-U. (Swiss Federal Inst. of Tech., Zurich). Int. J. Radiat. Biol.; 21: No. 5, 455-63 (May 1972).

Mature oocytes of triploid females of Drosophila melanogaster were more radiosensitive than those of diploid females when x irradiated with doses from 100 to 400 R 50 keV x rays. In the progeny of XX/Y females, more dominant lethals were expressed in individuals resulting from XX-bearing pro-nuclei than in individuals resulting from Y-bearing pro-nuclei. It was suggested that the results support the hypothesis that the amount of radiation-induced lethality in mature oocytes is proportional to the amount of chromosome material irradiated in the oocyte nucleus and tested after the formation of the maternal pro-nucleus, and that in mature oocytes the chromosomes represent the most important target for x-ray-induced lethality. (UK)

38722 RADIOSENSITIVITY OF OOCYTES OF DROSOPHILA. II. SENSITIVITY OF CLASS-B OOCYTES OF X/X AND XY/XY FEMALES. Wuergler, F. E.; Leuthold, U. (Swiss Federal Inst. of Tech., Zurich). Int. J. Radiat. Biol.; 21: No. 5, 465-73 (May 1972).

Class-B oocytes of X/X and XY/XY females were equally sensitive to the x-ray induction of lethal damage expressed after maturation and insemination (so-called embryonic lethality). On the other hand, class-A oocytes of the same types of female showed a difference in sensitivity, which was attributed to the higher content of chromosomal material in the oocyte nuclei of XY/XY females than X/X females. It was suggested that this indicated that in class-B oocytes, radiation-induced damage located in targets other than the oocyte chromosomes is of significance in the induction of embryonic lethality by radiation. Dose-response curves are presented for x radiation (50 keV) of class-B oocytes over a dose 0 to 6 Krads. (UK)

38723 NATURE OF REVERSION OF A DOMINANT GENE OF DROSOPHILA MELANOGASTER. Denell, R. E. (Univ. of California, San Diego, La Jolla). Mutat. Res.; 15: No. 2, 221-3 (Jun 1972).

Reversions of the homozygous viable, dominant gene, Nasobemia (Ns), of Drosophila melanogaster were investigated. Flies bearing the gene show a transformation of the antennal region into a mesothoracic leg. Male flies were given 4000 R of x radiation and the progeny were examined for antennal-leg transformations. A table is presented to show genotypes of progeny recovered with putative revertant-bearing chromosomes. Factors influencing reversion of dominant mutations are discussed. (H.L.W.)

38724 X-RAY INDUCED MITOTIC RECOMBINATION IN DROSOPHILA MELANOGASTER. I. ITS DEPENDENCE ON DOSE, DOSE-RATE, AND SPECTRUM. Haendle, Jutta (Univ., Munich). Mol. Gen. Genet.; 113: No. 2, 114-31(1971). (In German).

Mitotic recombination has been induced with x-rays in w/w^{co}-marked X-chromosomes of Drosophila melanogaster second instar larvae and assayed later as w; w^{co}-twin mosaic spots in the adult eyes. According to estimates at least 95% of the registered twin spots are due to mitotic recombination. The frequency with which mitotic recombination leads to twin spots can not be given in figures. The dependence of twin spot frequency on dose, dose-rate and spectrum was registered. The spectra of the four filter-voltage combinations used (45 kV, 0.55 mm Al; 55 kV, 0.78 mm Al; 85 kV, 1.25 mm Al; 100 kV, 1.7 mm Al) were measured by means of a solid state counter. The dose was measured with a Simplex dosimeter. For 100 kV the dependence of twin spot frequency on the dose has been investigated by two methods: the dose was varied by using different radiation times at a constant dose-rate and by using different dose-rates for a constant radiation time. Both dose effect curves (DEC) show a peculiar hump and subsequently a renewed rise of the curve. The course of the time-dependence curve at 100 kV shows that a DEC, which is to have the dose as the only parameter, has to be registered at irradiation times of 30 sec or less. The DEC's at 45 and 55 kV are identical; they differ considerably in form and altitude from those at 100 kV. The DEC at 85 kV lies between the two with respect to both, form and altitude. The results led to the conclusion that an irradiation with 100 kV triggers two reactions, which lead to twin spots in the eyes. There is no such indication for irradiation with 55 kV. A hint as to the nature of these two reactions and a possibility of an explanation for the different effects of 55 kV and 100 kV irradiation is seen in the different qualities of the two spectra. (auth)

38725 X-RAY INDUCED MITOTIC RECOMBINATION IN DROSOPHILA MELANOGASTER. II. THE EXISTENCE OF TWO SPECTRUM DEPENDENT REACTIONS IS PROVEN, AND BOTH THESE REACTIONS ARE CHARACTERIZED IN MORE DETAIL. Haendle, Jutta (Univ., Munich). Mol. Gen. Genet.; 113: No. 2, 132-49(1971). (In German).

When larvae of D. melanogaster are x-rayed (spectrum III: 100 kV, 1.7 mm Al-filter, W-target, 8 mA), mitotic recombination is induced and becomes visible later as twin mosaic spots in the adult eye. It was possible by separating the spectrum into two parts—a soft part (spectrum I: 55 kV, 0.78 mm Al-filter, W-target, 10 mA) and a hard part (spectrum II: 100 kV, 0.24 mm Ta-filter, W-target, 8 mA)—to show that there are two reactions which lead to mitotic recombination. By means of additional experiments the two reactions were examined in more detail: Reaction 1 shows a DEC, which can be described as effect = $(1 - e^{-kD})^x$ with x = 1.3. Therefore, it deviates significantly from a single-hit reaction. It rises, however, less steeply than a theoretical two-hit curve. This deviation from a squared dose-dependence is not due to a time factor, since the reaction does not show a time-dependence within the observed region. The deviation must be interpreted rather as a consequence of an increasing number of complex chromosomal aberrations with increasing dose, which diminish the number of two-break aberrations leading to a twin spot, and an increase of single-hit reactions with increasing dose. The frequency of reaction 1 depends exclusively on the dose in [R]; the reaction can be induced by all spectra investigated in this paper. Reaction 2 can be described as a breakage-fusion mechanism with a very short repair time; the second break necessary for a recombination must arise 30 sec after the first. Probably, these breaks are induced by the K-radiation of tungsten contained in spectra II and III described above. However, twin spots are observed in greater amounts only, when larvae are irradiated with spectrum I prior to irradiation with spectrum II. From these results it is concluded that a ''white radiation'' such as the one of spectrum I induces not only reaction 1 but, in addition, affects the pairing properties of the chromosomes. Only after pairing can the breaks induced by the K-lines of tungsten lead to mitotic recombination. (auth)

38726 CYTOGENETICS OF NUCLEOLUS-TRANSPOSITIONS IN DROSOPHILA MELANOGASTER. Hannah-Alava, Aloha (Univ. of Turku, Finland). Mol. Gen. Genet.; 113: No. 3, 191-203(1971).

The results from cytological identification of 125 radiation-induced specific-locus mutations revealed that the relative frequency of nucleolus-associated rearrangements could be increased substantially by selection of specific types of position-mutations for cytological analysis. One of the five nucleolus-involved rearrangements investigated was an inversion, $In(1)lz^{sB}$, and four were deletion-insertions: $Tp(1)ct^{6a1}$, $Tp(1)lz^{491}$, $Tp(1)lz^{144}$ and $Dp(1;3)in^{61j2}$. The cytomorphology of the transposed nucleolus and associated bands was easier to resolve in the salivary gland chromosomes of the rearrangements than when the nucleolus was in its normal position in the proximal region of the X-chromosome. However, the extent of the NO and adjacent chromatin involved in the transposition could not be positively delimited because of the tendency for a variegation-type alteration in the morphology of the bands adjacent to the transposed nucleolus. (auth)

38727 POST-RADIATION REPAIR AT SPECIFIC LOCI IN DROSOPHILA SPERMATIDS. Inagaki, E.; Sobels, F. H. Leiden Univ. Inst. for Radiopathology and Radiation Protection, Leiden). Mutat. Res.; 15: No. 2, 229-32(Jun 1972).

The frequencies of visible mutations recovered at certain specific loci from x-irradiated Drosophila pupal spermatids were used as criteria to investigate the effects of oxygen and nitrogen post-treatments. Male pupae were x-irradiated under anoxia and post-treated with nitrogen or oxygen. After eclosion the flies were mated with females of various genetic constitutions and F_1 flies were examined for whole-body and mosaic mutations at selected loci. Results are presented in the form of tables showing effects of nitrogen and oxygen post-treatments on the frequencies of mutations induced by 3000 R of x radiation in spermatids. (H.L.W.)

Radionuclide Effects (Internal Source)

Refer also to abstracts 38327 and 38809.

Man

38728 (HASL–253) RADIATION DOSE DUE TO ACUTE INTAKE OF TRITIUM BY MAN. Bennett, Burton G. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr 1972. 21p. Dep. NTIS.

Small amounts of tritium acquired as water by man are incorporated into tissue compounds and retained considerably longer than the 8 to 10 day half-time associated with retention in the body water. A review of the data from the few long-term observations of human cases of exposure to tritium shows that two bound components with retention half-times of about 30 and 450 days can be identified. A two compartment estimate and three compartment model calculations were made to determine the contribution to the tissue dose from tritium in the body water and in the bound compartments. For the average retention half-times of 9, 30, and 450 days, the tissue dose was 84 mrad per mCi intake, due 84% to tritium in body water and 16% to combined tritium in tissue. Fifty percent of the total tissue dose was delivered within 11 days and 90% within 200 days following the intake. The bound tritium in tissue was not the major contributor to the tissue dose following a single intake of HTO, but its contribution was not insignificant. (auth)

38729 DOSE TO THE LUNGS FOLLOWING ENDOLYMPHATIC RADIOTHERAPY WITH LIPIODOL F ^{131}I. Fava, Giannino; de Vecchi, Alberto; Sichirollo, Adele E.; Cordoni, Luciana (Istituto Nazionale Tumori, Milan). Radiol. Med.; 57: No. 7, 531-9(Jul 1971). (In Italian).

Calibrations on a phantom were employed in the evaluation of efficiency coefficients applicable to external determinations of lung ^{131}I concentration. These coefficients are used in a procedure for the assessment of lung doses following endolymphatic radiotherapy with Lipiodol F ^{131}I. (auth)

38730 ANALYTIC PROGNOSTICATION OF THE ABSORBED DOSE BY INHALATION OF RADIOACTIVE PARTICLES, PRODUCED AFTER A NUCLEAR EXPLOSION. Nikolov, Iv.; Paskalev, A.; Andreev, Em. Rentgenol. Radiol.; 9: No. 4, 270-3(1970). (In Russian).

An analytical method for estimating the dose absorbed by the lungs following inhalation of radioactive fallout particles is suggested. By using formulas for estimating the diameter of the particles, the speed of falling, and their activity, a calculation is made of the quantitity of radioactive particles, with dimensions up to 5 microns, to be found 2 meters above the Earth's surface after the 20th day of a nuclear explosion. The calculation for beta-radiating substances is performed according to the formula: $D\beta = AE\beta \cdot 3{,}7.10^{10} \cdot 1{,}6.10^{-6}/100$ rad and for gamma-radiating substances, as follows: $D\gamma = AE\gamma \cdot K \cdot 3{,}7.10^{10} \cdot 1{,}6.10^{-6}/100$ rad where K is the gamma-constant for barium-137 = 3.16. On the basis of the suggested method for analytic estimation, it is possible to make concrete determinations concerning the power of nuclear explosions. The data obtained are close in value to the data communicated by British research workers after the nuclear explosions in Nevada during 1951. This is to indicate that the method of analytic prognostication of the absorbed dose by the lungs may be used to prognosticate the radiation conditions following nuclear explosions. (Abstr. Bulg. Med. Sci. Lit.)

38731 FORTRAN PROGRAM FOR SYSTEMATIC DOSIMETRY BASED ON PERIODIC DETERMINATIONS OF RADIOACTIVITY UPTAKE. Guillot, P. (EURATOM-CCR, Ispra, Italy). Minerva Fisiconucl.; 15: No. 3, 97-104(Jul-Sep 1971). (In Italian).

An increasingly wide use is being made of radioisotopes and a growing number of persons are being chronically contaminated. Systematic dosimetry based on periodic radiotoxicology determinations or anthropogammametric values is proposed. Leaving aside accidents, during periods of regular examination, the following hypotheses can be advanced: activity taken up as a result of occupational exposure increases constantly as a function of time; retention during a period of 24 hr is a linear function; periodic measurements must be randomized during the day. If these conditions are maintained, the dose absorbed in the interval between two measurements will be a linear function of the activity. A Fortran IV program was prepared for dose estimations that can readily be adapted for any isotope if the above conditions are satisfied. (auth)

38732 BIOLOGICAL IMPLICATIONS OF THE TRANSURANIUM ELEMENTS FOR MAN. Parker, H. M. (Battelle-Northwest, Richland, Wash.). Health Phys.; 22: No. 6, 953-4(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

It is stated that during a 25-year span the pathological effects observed in personnel engaged in plutonium work have been minimal. The current steady growth of its use, the greatly increased use of plutonium isotopes other than ^{239}Pu, and the use of other transuranium elements are noted. It is pointed out that, although much work has been done on plutonium, there is a continuing uncertainty about low level effects, and in particular the question of whether one insoluble transuranium particle fixed in lung or lymph node may induce cancer. The way in which permanency is ascribed to the indices for MPC and MPBB by many is deplored. It is emphasized that, valuable as animal experiments are, the proper study of man is man, and it is conceivable that effects with a latency greater than 25 years may appear within the life span of this personnel group. (UK)

Animals

Refer also to abstracts 38760, 38769, 38771, and 38775.

38733 (COO–3229-1) RADIOTOXICITY OF INTRACELLULAR ^{125}I IN MAMMALIAN CELLS: EFFECTS ON THE SURVIVAL CURVE. Technical Progress Report. Adelstein, S. J.; Prince, Eileen W. (Harvard Medical School, Boston, Mass.). [1971]. Contract AT(11-1)-3229. 20p. Dep. NTIS.

The effects of ^{125}I incorporated into DNA as iododeoxyuridine (IudR) on the survival of cultured mammalian cells were investigated. Two cell lines, human liver cells (LICH) and Chinese hamster ovary cells (CHO) were used for the studies. Continuous exposure of cells from either line to unlabeled IudR at concentrations above 10^{-7} M proved to be toxic while exposure to 10^{-6} M unlabeled IudR for one doubling time did not influence the plating efficiency. Continuous exposure to ^{125}I-labeled IudR at concentrations above 10^{-10} M completely inhibited colony formation of the LICH cells and colony formation of the CHO cells was completely inhibited at concentrations above 10^{-11} M. Lower concentrations reduced the number of survivors of both cell lines. The mid lethal dose rate for 5×10^{-10} M ^{125}IudR was estimated to be approximately 85 keV/day per nucleus prior to the first cell division. (C.H.)

38734 SOME PATHOGENIC ASPECTS OF GROSS PATHOLOGICAL CHANGES IN ^{90}Sr-TREATED BONE OF NEWBORN RATS. Hopkins, B. J. H.; Casarett, G. W. (Univ. of Rochester, New York). Int. J. Radiat. Biol.; 21: No. 5, 405-16(May 1972).

Rats of the Long–Evans strain were given highly toxic doses of ^{90}Sr (2μCi ^{90}Sr/g body weight) on the second day of life. The strontium treated animals showed an initial hyperaemia in the shaft of the long bone, followed by extensive cell death and cessation of growth. Longitudinal (endochondrial) bone growth eventually recovered (between 28 and 32 days after strontium treatment), with cell repopulation of marrow in metaphyses. However, the mid-diaphysial region showed a persistent devitalized zone consisting of dead bone, cartilage, fibrous tissue and detritus. Spontaneous fracture at the site that had failed to heal was often a terminal complication at the time of death of the animal. Large numbers of deaths occurred between 30 and 40 days after injection between 5 and 10% survived 150 days. (UK)

38735 SELECTIVE RADIONECROSIS OF THE CHOROID PLEXUS FOR CONTROL OF EXPERIMENTAL HYDROCEPHALUS. Weiss, Martin H.; Nulsen, Frank E.; Kaufman, Benjamin (Veterans Administration Hospital, Cleveland. Case Western Reserve Univ., Cleveland). J. Neurosurg.; 36: No. 3, 270-5 (Mar 1972).

Hydrocephalic dogs treated with intraventricular colloidal ^{198}Au showed a sustained decrease in cerebrospinal fluid flow and intraventricular pressure associated with a reversal of progressive hydrocephalus. Gamma scanning and isotopic sampling, however, indicated a more diffuse distribution of the isotope than previously thought, although pathological changes up to 7 weeks post-instillation of the radioactive colloid appeared confined to the choroid plexus. (auth)

38736 DEUTERIUM OXIDE: INHIBITION OF CALCIUM RELEASE IN MUSCLE. Kaminer, Benjamin; Kimura, John (Boston Univ. Marine Biological Lab., Woods Hole, Mass.). Science; 176: No. 4033, 406-7(28 Apr 1972).

Calcium release, measured as luminescence of the protein aequorin, was measured simultaneously with membrane potential and isometric tension in single muscle fibers of the barnacle (Balanus nubilus). Deuterium oxide inhibited calcium release and isometric tension but did not affect membrane potential, a result consistent with the postulate that deuterium oxide inhibits the coupling between excitation and contraction. (auth)

38737 EFFECTS OF INTRA-ARTICULAR ^{198}Au INSTILLATIONS ON ARTICULAR CARTILAGE. Rubin, Philip; Casarett, George; Farrer, Paul (Univ. of Rochester, N. Y.). Radiology; 103: No. 3, 685-90(Jun 1972).

An experiment was devised to determine the effects of radiogold instillation on intra-articular tissue. Adult and weanling rats were injected with doses of ^{198}Au ranging from 1 to 10 mCi. Radiation-induced damage to articular cartilage occurred only in weanling rats at extremely high doses (2.5 to 5 mCi). Adult rat articular cartilage is extremely resistant to radiation damage and to high doses of ^{198}Au(5 to 10 mCi). Experimental evidence indicates a safety factor of 100 to 1000× exists in the dose (1mCi/0.1 ml) used clinically for the treatment of rheumatoid arthritis. (auth)

38738 LIFE SPAN, DISTRIBUTION, AND RADIOSENSITIVITY OF THE LARGE LYMPHOCYTE. Field, E. O.; Gibbs, J. E.; Stanley, E. M. (Royal Marsden Hospital, Sutton, Eng.). Nature (London) New Biol.; 237: No. 74, 152-4(31 May 1972).

A study was made of the distribution of radioactivity found between different classes of leukocytes in rats injected with tritiated thymidine (^{3}H-TdR). Six rats, initially weighing 60 to 80g, were injected daily 5 days/week for 3 weeks with ^{3}H-TdR, to a total dose of 2mCi/rat. Autoradiographs of whole blood smears were prepared at the end of the injection course and 14 days later. At the end of the injections, 29% of the label was in the neutrophils, 44% in lymphocytes of nuclear diameter >7.1 μ and 27% in smaller lymphocytes. From these results and studies of cross-circulation with unirradiated rats (when the animals weighed 150 to 180g), it was concluded that blood lymphocytes with nuclear diameters from 7 to 10 μ comprised a distinct class of leukocytes largely confined to the blood, with a half life of ~10 days. Assuming that they are largely confined to the blood, it was estimated that 91% were at risk from extra-corporeal irradiation during cross-circulation, and of these, 68% survived at least 600 rad. (UK)

38739 BIOLOGICAL ACTION OF URANIUM TETRAFLUORIDE IN CHRONIC INHALATION POISONING. Galibin, G. P.; Petrovich, I. K. Gig. Sanit.; No. 2, 60-4(Feb 1972). (In Russian).

Experiments performed in rats showed daily 4 hr chronic inhalation of uranium tetrafluoride at a concentration of 12 mg/m^3 to be definitely toxic for rats; a concentration of 1.2 mg/m^3 approached the minimum efficient value of the threshold level of the substance. The early signs of the toxicity of uranium tetrafluoride were the fall in the body weight and disturbances of the function of the liver and kidneys. Changes in the amount of uranium deposited in the organs showed that in chronic inhalation of uranium tetrafluoride at a concentration of 1.2 mg/m^3 tissue doses (owing to γ-radiation-approaching the maximum permissible level (15 ber/yr)) may occur only in the lungs. In the rest of the organs and tissues these doses were by 1 to 2 lg lower than the maximum permissible one, recommended by the International Committee on Radiologic Protection. (auth)

38740 EXPERIMENTAL EVALUATION OF THE EFFECTS OF TRANSURANIC ELEMENTS ON REPRODUCTIVE ABILITY. Ovcharenko, E. P. (Inst. of Biophysics, Moscow). Health Phys.; 22: No. 6, 641(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The tests were performed on 5,000 rats of the Wistar strain, including parents of both sexes, throughout their active reproductive life; the first generation offspring from day 4 of antenatal life to sexual maturity; and the second generation offspring. With the elements studied, ^{239}Pu, ^{241}Am and ^{237}Np, there was high retention in the placenta, an increased transplacental transfer to the offspring during the late periods of pregnancy and a decrease with age of the radionuclide content in the carcasses of sucklings. (UK)

38741 BIOLOGICAL EFFECTIVENESS OF ^{237}Np. Levdik, T. I.; Lemberg, V. K.; Buldakov, L. A.; Lyubchanskii, E. R.; Pesternikov, V. M. (Inst. of Biophysics, Moscow). Health Phys.; 22: No. 6, 643-5(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The intravenous injection of neptunium-237 nitrate and oxalate in rats at doses ranging from 2.0 to 0.017 μCi/kg was characterized by the occurrence of osteosarcomas (incidence ranging from 58 to 9% at cumulative skeletal radiation doses ranging from 520 to 5 rads, respectively). The major manifestations of injury after intratracheal administration of the two neptunium compounds at the same doses were the development of pneumosclerosis and malignant lung tumors (incidence ranging from 37 to 11% at cumulative lung doses of 3220 to 5 rads, respectively); and, to a lesser extent, of osteosarcomas (incidence ranging from 25 to 5% at skeletal doses of 408 to 4 rads, respectively). (auth)

38742 IN VIVO CYTOGENETIC EFFECTS OF ^{252}Cf ON LIVER AND BONE MARROW OF THE CHINESE HAMSTER. Brooks, A. L.; Mewhinney, J. A.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 22: No. 6, 701-6(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Hamsters were injected with graded activities of ^{252}Cf citrate at pH 6.0 (4.5×10^{-2}, 1.5×10^{-2}, 5×10^{-3}, 1.7×10^{-3} and 5.6×10^{-4} μCi/g body weight), and sacrificed at 6, 15 and 42 days post-injection. The frequency of chromosome aberrations in the bone marrow was very low at all times and activity levels. When the animals injected with the three highest levels of ^{252}Cf were considered collectively, the aberration frequency was four times that of the control animals. Many of the aberrations were balanced and had apparently survived cell division. These results suggest that rapidly dividing tissues, such as bone marrow, do not reflect chromosome damage from chronic irradiation to the same degree as slowly dividing tissues, such as liver, because cell division appears to select against damaged cells. The frequency of rings plus dicentrics in the liver, fitted by a power function and a linear regression, increased according to the 1.0 power of the dose with a coefficient of aberration production of 1.7×10^{-3} aberrations/cell/rad. There was a linear increase in the total aberration frequency in liver cells with increasing dose through all the time intervals studied. This increase could be described by the equation $Y = 0.05 + 3.3 \times 10^{-3} D$ where Y = aberrations/cell and D is dose in rads. The coefficient of 3.3×10^{-3} aberrations/cell/rad was approximately half the 7.1×10^{-3} aberrations/cell/rad seen following exposure to ^{241}Am, a pure alpha emitting radionuclide. When only the dose from the alpha emissions of the ^{252}Cf was considered, the aberration coefficient (6.3×10^{-3} aberrations/cell/rad) was not significantly different from that for ^{241}Am. (auth)

38743 ^{239}Pu: PROBLEMS OF ITS BIOLOGICAL EFFECT. Moskalev, Yu. I. (Inst. of Biophysics, Moscow). Health Phys.; 22: No. 6, 723-9(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The results of recent studies on problems of the biological action of ^{239}Pu, one of the most dangerous radionuclides, are reviewed. The biological action of various compounds of this radionuclide is considered as a function of the dose, routes and character of the intake into the body, including inhalation, intravenous and subcutaneous administration. Main attention is given to the analysis of late effects (tumor and non-tumor effects) developing in the body of rats as a result of injury by ^{239}Pu: dose-effect curves for bone and lung tumors, estimation of minimum carcinogenic dose levels, and determination of doses not affecting the natural life-span. (auth)

38744 METABOLISM AND EFFECT OF MONOMERIC AND POLYMERIC PLUTONIUM IN THE IMMATURE RAT LIVER. Kashima, M.; Mahlum, D. D.; Sikov, M. R. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 749-52(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The distribution of monomeric and polymeric ^{239}Pu after administration to newborn, week-old, weanling, or adult rats was studied autoradiographically. The effects of ^{239}Pu on the liver were evaluated using hepatic incorporation of ^{198}Au-colloid and blood clearance of ^{131}I-rose bengal. The uptake of gold by the liver was markedly decreased at 21 days after exposure of newborn or week-old rats to 60 μCi/kg monomeric ^{239}Pu. Polymeric ^{239}Pu (30 μCi/kg) decreased gold uptake only in animals injected as newborns. Blood clearance of ^{131}I-rose bengal was decreased in animals injected at birth or at 1 week of age with either monomeric or polymeric ^{239}Pu. Animals injected as weanlings or adults with either form showed no impairment of ability to clear ^{131}I-rose bengal from the blood or to incorporate ^{198}Au into the liver. (auth)

38745 MECHANISM OF DEVELOPMENT OF PLUTONIUM-INDUCED PULMONARY SCLEROSIS. Koshurnikova, N. A.; Aristov, V. P.; Lemberg, V. K.; (and others) (Inst. of Biophysics, Moscow). Health Phys.; 22: No. 6, 753-4(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The mechanism of development of plutonium-induced pulmonary sclerosis following the inhalation of soluble ^{239}Pu compounds was studied by light and electron microscopy and with biochemical methods. Plutonium-induced pulmonary sclerosis is a consequence of radiation injury. The effects seen are due to excessive reparative functioning of connective tissue when disturbance of physiological regeneration takes place, and due to intensified destruction of parenchyma as a result of radiation injury. Endothelial elements of capillaries show the greatest susceptibility to radiation damage. Interalveolar sclerosis develops as a consequence of intensified proliferation of fibroblasts. Collagen fibers are formed in the basal layer of the alveolar-capillary barrier and in positions previously occupied by capillaries. Infection and the consequent aggravation of pneumonic processes are significant factors in development of sclerosis. (auth)

38746 INDUCTION OF MESOTHELIOMAS AND SARCOMAS FROM HOT SPOTS OF $^{239}PuO_2$ ACTIVITY. Sanders, C. L.; Jackson, T. A. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 755-9(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Albino rats were given an intraperitoneal injection of approximately 2.8 μCi, submicron-sized $^{239}PuO_2$ particles. From 30 to 35% of the initially injected dose was found in the omentum within fibrous adhesions by 6 months after plutonium injection. About 27% of the animals developed mesotheliomas and 38% sarcomas of various types. All but 3 of these tumors originated from the omental area with a median induction period of about 1 yr. The tumors spread by implantation on serosal surfaces, by infiltration and by metastasis. In addition to omental tumors, two osteogenic sarcomas and one reticulum cell sarcoma were found in PuO_2 animals. The pathogenesis of PuO_2-induced mesothelioma was similar to previously described mesothelioma formation following intracavitary administration of asbestos fibers. The distribution of PuO_2 in fibrous adhesions was similar to that seen in tracheobronchial lymph nodes of beagle dogs following inhalation of $^{239}PuO_2$. Likely sites for tumor formation from inhaled PuO_2 may include mesenchymal tissue from lungs and thoracic lymph nodes and mesothelial lining of the pleura, particularly when the PuO_2 is redistributed into "hot spots" of alpha activity. (auth)

38747 PROGRESS IN BEAGLE DOG STUDIES WITH TRANSURANIUM ELEMENTS AT BATTELLE-NORTHWEST. Park, J. F.; Bair, W. J.; Busch, R. H. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 803-10(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Studies were initiated 10 to 12 yr ago to determine the biological effects of inhaled plutonium. Sixty-five beagle dogs inhaled $^{239}PuO_2$ and were held for life-span observations. Sixty dogs died or were euthanized when death was imminent due to plutonium-induced pulmonary fibrosis and/or neoplasia 2 to 135 months postexposure. Twenty-four of the dogs had primary pulmonary neoplasia, including 20 of the 21 dogs that survived at least 4.5 yr post-exposure. Most lung tumors were bronchiolo–alveolar carcinomas of peripheral origin with metastases to several other tissues. Two squamous cell carcinomas, three epidermoid carcinomas and three thoracic sarcomas were also observed. The estimated initial alveolar deposition in the dogs with plutonium-induced tumors ranged from 0.2 to 3.3 μCi. Approximately 10% of the alveolar-deposited plutonium was retained in the lungs after 8 to 10 yr postexposure, with an accumulated average radiation dose to the lungs of 2000 to 12,000 rads in the tumor-bearing dogs. Forty to fifty percent of the plutonium was translocated to the tracheobronchial and mediastinal lymph nodes, 10 to 15% to the liver, 5% to the skeleton and 5% to the abdominal lymph nodes. The highest plutonium concentrations occurred in the tracheobronchial, mediastinal and abdominal lymph nodes, followed in descending order by lungs, liver and skeleton. Respiratory insufficiency and lymphopenia were the primary clinical signs associated with the fibrotic, metaplastic and neoplastic changes in the lungs, and with the fibrosis of the lymph nodes. The pathology in these tissues may have influenced the clearance and translocation rates of the plutonium. Alveolar deposition of more than about 1 nCi/g of lung, about 30 times the quantity, at equilibrium, resulting in an average lung dose of 0.3 rem/week, might be expected to cause premature death due to pulmonary pathology. Experiments were initiated in 1970 to study dose-effect relationships at low dose levels in 200 dogs depositing 0.002 to 3.0 μCi of $^{239}PuO_2$ or $^{238}PuO_2$. The lowest level corresponds to an average lung dose of 0.3 rem/week. This study should further identify the critical tissues for inhaled plutonium at low dose levels. (auth)

38748 LIFE SHORTENING CONSEQUENT TO INTERNAL IRRADIATION FROM ^{239}Pu. Stover, Betsy J. (Univ. of North Carolina, Chapel Hill. Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6. 823-7(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Survival data for beagles at 6 dose levels of ^{239}Pu, which range from 0.016 to 2.9 μCi ^{239}Pu/kg injected, are compared with those for beagles that received no ^{239}Pu. The criterion for life shortening is that defined mathematically by the Steady State Theory of Mutation Rates. A brief summary of this theory is presented. The life-shortening decreased with decreasing dose level through the first 5 levels but none was observed at the lowest level. The death rate curves for the lowest dose level and the controls were essentially coincident. Osteosarcomas do occur at this dose level, so it may be a matter of trading of causes of death rather than decreasing the length of the animal's life. A brief commentary on the chemistry of plutonium and the trans-plutonic elements is included. The retention and distribution of plutonium in these beagles is reviewed. Finally, suggestions are made about experimental factors that should be varied in order to evaluate the toxic effects of plutonium. (auth)

38749 METABOLISM, DOSIMETRY, AND BIOLOGICAL EFFECTS OF INHALED ^{241}Am IN BEAGLE DOGS. Thomas, R. G.; McClellan, R. O.; Thomas, Randi L.; (and others) (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 22: No. 6, 863-71(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Five Beagle dogs were exposed by inhalation to an aerosol formed by passing liquid droplets containing ^{241}Am through a heating column at 600°C. The resulting particles, presumed to to be relatively insoluble, had a median aerodynamic diameter of ~0.9 μm and a geometric standard deviation of ~1.5. One dog was frozen shortly post-inhalation and used as a counting standard; the remaining four were held for urine and feces collections for up to 138 days; these four were sacrificed at 127, 256, 512, and 1022 days post-exposure. Initial body burdens ranged from 4.4 to 4.9 μCi/kg. Tissue analyses indicated the greatest long-term doses to be received by the tracheobronchial lymph nodes, liver, lung, bones, and thyroid in descending order. Respiratory measurements showed increased frequency and decreased tidal volumes in the two early sacrifice dogs only. Hematologic findings included reduced total white cells, platelets, lymphocytes, and neutrophils, but little change in hematocrit. Pathologic findings centered around fibrotic changes in lung and lymph nodes, fatty deposits and cellular degeneration in liver, bone marrow depletion, glomerulosclerosis, and severely damaged thyroid. (auth)

38750 METABOLISM AND BIOLOGICAL EFFECTS OF INHALED ^{241}Am AND ^{239}Pu IN DOGS. Buldakov, L. A.; Kalmykova, Z. I.; Nifatov, A. P.; (and others) (Inst. of Biophysics, Moscow). Health Phys.; 22: No. 6, 873-4(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements, Richland, Wash. (27 Sep 1971). See CONF-710919.

Investigations were carried out on 132 dogs exposed by inhalation of radioactive aerosols of $^{241}Am(NO_3)_3$ and polymeric $^{239}Pu(NO_3)_4$, pH 1.5 to 2.0. The results of observing these animals for two years indicate a total elimination in urine and feces, of 20% of the ^{241}Am and 6 to 13% of polymeric ^{239}Pu. The ^{241}Am and ^{239}Pu content in lungs, liver, and skeleton at various times are tabulated. The biological differences of inhaling $^{241}Am(NO_3)_3$ and polymeric $^{239}Pu(NO_3)_4$ are discussed and it is concluded that the major manifestations of injury are the occurrence of pneumonia and pulmonary sclerosis with respiratory insufficiency and the disturbance of blood formation in the form of leukopenia and depression of myelopoiesis. (UK)

38751 SOME LATE EFFECTS AFTER A SINGLE INHALATION OF ^{239}Pu AND ^{241}Am IN DOGS. Nifatov, A. P.; Buldakov, L. A.; Matveev, V. I. (Inst. of Biophysics, Moscow). Health Phys.; 22: No. 6, 875(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements, Richland, Wash. (27 Sep 1971). See CONF-710919.

The micro-distribution of ^{239}Pu and ^{241}Am in the lungs and morphological changes in pulmonary tissue and bones were studied in 50 dogs that inhaled either polymeric ^{239}Pu(NO$_3$)$_4$ or ^{241}Am(NO$_3$)$_3$. The most dangerous consequence of a single inhalation of ^{241}Am was found to be the occurrence of osteogenic sarcomas. After inhalation of relatively insoluble polymeric ^{239}Pu the major tissue damage was found in the lungs. The characteristics of the morphological changes are discussed. It is concluded that the differences in the late effects after ^{239}Pu and ^{241}Am injury were apparently due to a dissimilar pattern of gross distribution in the organism, and of microdistribution in the pulmonary tissue. In the late periods of observation, not more than 6% of the administered ^{241}Am was retained in the pulmonary tissue, whereas up to 55% was accumulated in the skeleton. The content of polymeric ^{239}Pu in the lung tissue, in comparison with that of readily soluble ^{241}Am, was higher and was equivalent to about 50% of the amount initially deposited in the lungs. (UK)

Nuclide Kinetics and Toxicology

Refer also to abstract 38651.

Man

Refer also to abstract 38422.

38752 (ORO-2401-51) ESTIMATION OF RADIOACTIVE CONTENT OF BODY ORGANS COMBINING DIRECT MEASUREMENTS AND DISTRIBUTION MODELS. Price, R. R.; Johnston, R. E.; Brill, A. B.; Watts, J. R. (Veterans Administration Hospital, Nashville, Tenn. (USA). Vanderbilt Univ., Nashville, Tenn.). [1971]. Contract AT(40-1)-2401. 21p. (CONF-711104-4). Dep. NTIS.

From Symposium on the assessment of radioactive organ and body burdens; Stockholm, Sweden (22 Nov 1971).

A system for making external measurements of internal distributions of radioactive sources is described. Using a low-level rectilinear whole-body scanner and digital data acquisition system, it is possible to make absolute quantitative determinations of organ radioactivity as a function of time after administration. The problems involved in making an absolute quantitative measurement of internal radiation sources are: variations of body thickness from patient to patient as well as within a given patient; variations in source organ volume; depth of the source within the body; and the assessment of radioactivity in surrounding tissues. By combining the quantitative organ measurements and the application of compartmental model analysis, these variables can be accounted for and a reasonably accurate absolute quantitative assessment of organ activity can be made. (E.R.B.)

38753 INTERPRETATION OF HUMAN URINARY EXCRETION OF PLUTONIUM FOR CASES TREATED WITH DTPA. Jech, J. J.; Andersen, B. V.; Heid, K. R. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 787-92(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Urinary excretion data are reviewed for selected human cases which were treated with DTPA following plutonium intake via inhalation or wound injection. Data obtained out to several years post intake are compared to the data for non-treated cases. These data point out the difficulties involved in determining the effectiveness of the DTPA and in evaluating the systemic deposition. Utilizing urine results obtained between treatment dates to determine the DTPA effect may be misleading, underestimate the effectiveness, and result in a premature cessation of treatment. The extended data indicate that the urine excretion rates eventually stabilize to the rates predicted by the Langham or Healy models. However, the rates appear to remain elevated above that expected for periods up to a hundred days post treatment. Evaluations based on data in the period prior to stabilization of the excretion rate may lead to overestimates of the systemic deposition. (auth)

38754 U. S. TRANSURANIUM REGISTRY: A PROGRESS REPORT. Norcross, John A.; Newton, C. E. Jr. (Hanford Environmental Health Foundation, Richland, Wash.). Contract AT(45-1)-1837. Health Phys.; 22: No. 6, 887-90(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

During the summer of 1968, the Atomic Energy Commission authorized the establishment of the U. S. Transuranium Registry. The Registry is part of the organizational structure of the Hanford Environmental Health Foundation and is, in essence, a repository for all pertinent information available to identify any radiation hazard to the worker that may exist from exposure to transuranium elements. The major AEC contractors and a few of the licensees using plutonium and other transuranium elements have agreed to endorse and recommend that their affected employees support this program. Cooperation with the Registry is individually voluntary and includes release of medical and health physics data, and permission for postmortem analysis of certain organs. (auth)

38755 COMPARISON OF MANUAL AND COMPUTER EVALUATION OF SYSTEMIC PLUTONIUM BURDEN. Bramson, P. E.; Jech, J. J.; Andersen, B. V. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 911-20(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Six well-documented plutonium exposure cases were evaluated manually at Hanford and by computer program at Los Alamos Scientific Laboratory and Oak Ridge National Laboratory. The systemic burden evaluations agreed within a factor of 2 for 5 of the cases and within a factor of 4 for the 6th case. Three cases had received varying degrees of chelation (DTPA) treatment but the evaluations did not appear to be differentially affected when compared to the untreated cases. (auth)

38756 DISTRIBUTION OF PLUTONIUM AND AMERICIUM IN THE BODY 5 YEARS AFTER AN EXPOSURE VIA CONTAMINATED PUNCTURED WOUND. Lagerquist, C. R.; Hammond, S. E.; Hylton, D. B. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Health Phys.; 22: No. 6, 921-4(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

In October 1970, a 59-yr-old employee of The Dow Chemical Company died from complications following open heart surgery. Tissue samples were obtained from autopsy and analyzed for plutonium and americium. This employee had suffered a plutonium-contaminated puncture wound in November 1965. This puncture wound contained a measured 18.5 μg of plutonium which was reduced to 5.9 μg by surgical excision. A second excision in August 1967 removed all but 0.3 μg. At the time of this puncture wound, this employee had an estimated 21% of the maximum permissible systemic burden based on urine analysis. A systemic burden was estimated each year following the wound and increased each year until at the time of death was 541% of the maximum permissible amount. An extrapolation of the plutonium content in the body based on tissue analysis showed 177% of the maximum permissible amount. (auth)

38757 PROBLEMS ASSOCIATED WITH SETTING SAFE LEVELS FOR WORKING WITH PLUTONIUM. Dolphin, G. W. (National Radiological Protection Board, Harwell, Eng.). Health Phys.; 22: No. 6, 937-42(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

A brief review is given of the problems of choosing a critical organ for use in the radiological protection of workers and populations exposed to plutonium. Mathematical models to represent lung clearance and retention, transfer from the blood to body organs and organ retention are summarized. From these models values of (MPC)$_a$ and MPBB are calculated and a value of 10^{-11} μCi/cm^3 is proposed as an appropriate value for adequately protecting workers. (auth)

38758 BIOLOGICAL IMPLICATIONS OF THE TRANSURANIUM ELEMENTS FOR MAN. Langham, W. H. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 22: No. 6, 943-52(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The production of plutonium, its role in future power production, its use as fuel capsules for thermoelectric generators for applications in space, and applications of plutonium for power supplies for blood circulation assist devices are discussed. The biological implications of ^{238}Pu and ^{239}Pu for man, including contamination of the environment, protection criteria, and practical problems for the future are considered. (UK)

Animals

Refer also to abstracts 38479, 38668, and 38695.

38759 (AEC-tr-7306, pp 153-9) KINETICS AND MECHANISM OF ACCUMULATION OF PLUTONIUM BY MISGURNUS FOSSILIS SPAWN. Patin, S. A.; Pechkurenkov, V. L.; Shekhanova, I. A. (All-Union Research Inst. of Sea Fisheries and Oceanography, Moscow). Translated from Radiobiologiya; 11: No. 5, 742-6(Sep-Oct 1971).

A series of experiments was performed to study the accumulation of plutonium-239 by live and dead Misgurnus fossilis spawn. The intensity of accumulation was found to be related to the phase of embryogenesis because of change in the membranes of the spawn. The bulk of the plutonium was adsorbed on the membrane of live spawn. In dead spawn, the adsorption of plutonium was virtually irreversible. (tr-auth)

38760 (AEC-tr-7306, pp 160-8) BIOLOGICAL EFFECTIVENESS OF ^{237}Np. Levdik, T. I.; Lembert, V. K.; Buldakov, L. A.; Lyubchanskii, E. R.; Pesternikov, V. M. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 5, 747-53 (Sep-Oct 1971).

Osteosarcomas, pneumosclerosis, and lung tumors characteristically developed at remote periods after exposure to neptunium-237. These phenomena varied with the dose, method of administration, and form of the compound. They were etiologically related both to its chemical toxicity and radiation effect. Neptunium-237 was found to be more potent in inducing osteosarcomas and lung tumors than plutonium-239 or americium-241. (tr-auth)

38761 (COO-1156-42) RADIOCESIUM RETENTION BY RAINBOW TROUT AS AFFECTED BY TEMPERATURE AND WEIGHT. Gallegos, A. F.; Whicker, F. W. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). [1970]. Contract AT(11-1)-1156. 25p. (CONF-710501-52). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

In a study aimed at characterizing accumulation by trout of fallout ^{137}Cs in a Colorado montane lake, it became important to study the effect of weight and water temperature on their accumulation pattern. An aquarium system with refrigeration capacity, and provision for waste removal was developed to test these effects in rainbow trout (Salmo gairdneri). A bio-oxidation column was constructed to treat dissolved wastes produced by the fish. Ten fish between 30 to 200 grams live weight were studied in this system for over 200 days. Rainbow trout were tested for radiocesium retention at 5.0, 8.3, 12.7, and 18.3°C. Cs-134 was injected by gavage and the fish were whole-body counted using a 5 cm × 5 cm NaI(Tl) scintillation crystal. Multiple regression analysis of radiocesium retention against time after dosing, and with a weight/temperature interaction term proved significant (R = 0.9; 2, 136 d.f.). Retention half-times obtained from the long component of excretion showed significant correlation (R = 0.8, 2, 29 d.f.) with a weighted average weight/temperature interaction term, and with the fractional weight change of the fish during testing. Experiments imply that maximum cesium intake and retention by fish would be achieved at water temperatures which were optimal for food consumption and growth. (auth)

38762 BIOLOGICAL HALF-LIFE STUDIES OF TRITIUM IN CHRONICALLY EXPOSED KANGAROO RATS. Martin, J. R.; Koranda, J. J. (Univ. of California, Livermore). Radiat. Res.; 50: No. 2, 426-40(May 1972).

The biological half-life of tritium was measured in the body water and in brain, liver, lung, kidney, heart and muscle tissues of two groups of kangaroo rats captured in the tritiated environment at Sedan Crater in the Nevada Test Site. These animals had been exposed to tritium in their natural food for their entire lifetime. The rodents were maintained on tritium-free food in the laboratory during the two study periods of five and nine months. At regular intervals, several animals from each group were killed, dissected and lyophilized. Tritium in the body water was determined by liquid scintillation counting. Dried tissue residues were assayed by sealed-flask combustion and liquid scintillation counting. The biological half-life of tritium in the tissue compartment of these uniquely exposed animals was 1.5 to 4 times that of the body water. At the time of trapping, a slight enrichment of tritium in tissue was indicated by the initial ratio of tissue to body water tritium which ranged from 1.2 to 1.6 with an average value of 1.40 ± 0.14. (auth)

38763 ZIRCONIUM PHOSPHATE IN INTERNAL ^{137}Cs DECONTAMINATION IN THE RAT. Testa, C.; Foresti, V. (CNEN-CSN, Casaccia, Italy). Minerva Fisiconucl.; 15: No. 3, 105-19 (Jul-Sep 1971). (In Italian).

Zirconium phosphate (ZP) is a practically insoluble inorganic cationic exchanger with a high selectivity for cesium, even at acid pH values. In vitro studies were run to determine the best ZP pH, granulometric, quantity, and stirring time values for the absorption of cesium. These were followed by the determination of cesium half-life times in the rat under normal conditions and after the administration of cesium by intubation. Three points were noted: under normal conditions, the retention curve is expressed by two exponentials; oral administration of ^{137}Cs, followed by ZP, leads to an up to 4-fold reduction in retention: fecal excretion is greatly increased, urinary excretion much less so, the former being directly proportional to the timeliness of treatment, and the amount and fineness of the ZP powder administered; i.v. radioisotope administration is followed by retention values that are little influenced by ZP; a slight increase in stool excretion is due to endogenous intestinal secretion of the elements. (auth)

38764 ^{90}Sr AND ^{137}Cs IN MILK AND CERTAIN OTHER MATERIALS COLLECTED IN FINLAND. Baker, B. E. (McGill Univ., Montreal); Samuels, E. R.; Pulliainen, Erkki. J. Dairy Sci.; 55: No. 5, 633-9(May 1972). (NYO-3901-15).

Sixty samples of human milk, 18 of bovine milk, 15 of reindeer milk, 1 of reindeer meat, and different lichens, all collected in Finland, were analyzed for ^{90}Sr and ^{137}Cs. Reindeer milk contained the most ^{90}Sr, being 119 pCi per liter. Only 5 samples of human milk had detectable amounts of ^{90}Sr and 4 came from north of Oulu. Human milk from north and south of Oulu contained 114 and 19.7 pCi per liter of ^{137}Cs whereas bovine milk from the same regions contained 125 and 84 pCi per liter of ^{137}Cs. Reindeer milk from Lapland contained 1,647 pCi per liter of ^{137}Cs which is 13 to 14 times more than that of human and bovine milk from the same area. A specimen of dried reindeer meat contained per kilogram, 237 pCi of ^{90}Sr and 76,124 pCi of ^{137}Cs. A sample of lichen, Cladonia species, contained 1,361 pCi of ^{90}Sr and 21,173 pCi of ^{137}Cs per kilogram. (auth)

38765 FATE OF THE THORIUM DAUGHTER RADIONUCLIDES ^{232}Th, ^{228}Th, ^{224}Ra, ^{212}Pb, AND ^{212}Bi IN RATS FOLLOWING INTRATRACHEAL INTRODUCTION OF THORIUM DIOXIDE. Pavlovskaya, N. A.; Makeeva, L. G. (Inst. of Hygiene and Occupational Disease, Moscow). Gig. Sanit.; No. 2, 65-9(Feb 1972). (In Russian).

The distribution and retention kinetics of the ^{232}Th daughter radionuclides (^{228}Th, ^{224}Ra, ^{212}Pb, ^{212}Bi) was studied in the organs and tissues of rats following intratracheal introduction of thorium in the form of a weakly soluble compound (ThO_2). No noticeable shift of the isotopic balance was detected in the lungs, lymphatic nodules, trachea and stomach. However, a significant disturbance of the thorium balance was noted to develop in bone tissue, liver, kidneys, spleen, and blood. Radium-224 was found to accumulate mainly in the bone tissues and ^{212}Pb and ^{212}Bi in kidneys. (auth)

38766 BIOLOGICAL IMPLICATIONS OF THE TRANSURANIUM ELEMENTS. Proceedings of the Eleventh Hanford Biology Symposium Held at Richland, Washington, 27-29 September 1971. Thompson, R. C.; Bair, W. J. (eds.). Health Phys.; 22: No. 6, 533-954(Jun 1972). (CONF-710919).

Separate abstracts were prepared on 59 papers. Six papers were abstracted previously and appeared in NSA. (C.H.)

For abstracts of individual papers see: 38419–38421, 38479, 38732, 38740–38751, 38753–38758, 38767–38801, and 38804.

38767 TRANSFER OF PLUTONIUM FROM MILK INTO CHEESE. Miller, C. L.; Payne, J. G. Jr.; Bretthauer, E. W.; Moghissi, A. A. (Western Environmental Research Lab., Las Vegas, Nev.). Health Phys.; 22: No. 6, 563-5(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Plutonium-238 in citrate solution was added to cows' milk and was injected intravenously into goats. Aliquots of milk were refrigerated, or pasteurized and refrigerated, and held for preselected time periods ranging from 0.1 day to 8.0 days. Rennin-coagulated cheese was then prepared from the aliquots and plutonium analyses were conducted on the cheese and whey samples. The results showed plutonium transfers of 97.5 ± 2.2% to the cheeses in all cases; in vivo and in vitro labeled milk, pasteurized and nonpasteurized, stored and non-stored milk. This quantitative transfer is probably due to coprecipitation of the plutonium with milk solids. (UK)

38768 INTERACTIONS BETWEEN TRANSURANIUM ELEMENTS AND THE COMPONENTS OF CELLS AND TISSUES. Taylor, D. M. (Inst. of Cancer Research, Sutton, Eng.). Health Phys.; 22: No. 6, 575-81(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Comparative studies of the interactions of plutonium, americium and curium with serum proteins from various species, with proteins isolated from the organic matrix of bone, and with some other proteins all showed that plutonium is bound very much more firmly by protein than either americium or curium. Investigations of the sub-cellular distribution patterns of these elements in liver and testes showed that all three elements become associated with lysosomal structures and that different mechanisms of lysosomal uptake are involved for polymeric and monomeric plutonium, americium and curium. The implications of these findings are discussed in relation to the types of biological damage which were observed in experimental animals. (UK)

38769 DISTRIBUTION AND TOXICITY OF ^{239}Pu IN BONE. Jee, Webster S. S. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6, 583-95(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The deposition of ^{239}Pu, the classical transuranium element, upon bone surfaces is governed by the route of administration, physicochemical state of the plutonium, and the age of the animal. The effectiveness of the various routes of administration in delivering plutonium to bone, in decreasing order, is: intravenous $\simeq$ intraperitoneal > subcutaneous > intramuscular > intratracheal > inhalation > oral > direct application upon skin. Reticuloendothelial cells in the marrow compete with bone for polymeric plutonium and thus decrease the plutonium available for bone surfaces. The uptake in young and adult bones differed by a factor of 2. The fate of the plutonium surface deposits is modified by bone growth, modeling and remodeling in growing animals and remodeling in adults. These age-related processes remove the plutonium from bone surfaces and/or bury the surface deposits with new bone. The endpoints of low dose plutonium skeletal toxicity are bone necrosis and the induction of osteogenic sarcoma. The factors involved in bone tumor production are believed to be the delivery of sufficient radiation to bone surfaces (the sensitive site), the volume of cells at risk and, most important, the proliferative activity of the osteogenic tissue. (auth)

38770 DEPOSITION PATTERNS AND TOXICITY OF PLUTONIUM AND AMERICIUM IN LIVER. Lindenbaum, Arthur; Rosenthal, Marcia W. (Argonne National Lab., Ill.). Health Phys.; 22: No. 6, 597-605(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The deposition and retention of plutonium and americium in the mammalian liver after administration of about 5 μCi/kg or less are briefly reviewed. Inferences are drawn regarding physiological mechanisms and radiotoxic consequences. The initial deposition patterns, but not the retention patterns, of plutonium and americium in the liver are generally similar in a variety of species. The major biological process responsible for the variable and non-uniform hepatic deposition appears to be phagocytosis. The amount of radionuclide phagocytized is dependent upon the extent of hydrolysis and polymerization of the administered actinide. The different biological half-times of plutonium and americium in the liver of different species suggest that there may be species differences in phagocytic function, protein binding, etc. The main route of elimination of plutonium (and probably americium) is via the bile and feces. There is a gradual aggregation of radionuclide by Kupffer cells and, at least in the mouse, also by parenchymal cells. This aggregation is believed to result from a repeated sequence of phagocytosis, irradiation death of the phagocyte, and rephagocytosis. In the mouse and dog, 20 nCi of ^{239}Pu or ^{241}Am per gram of liver appears to be the threshold concentration that results in sufficient radiation-induced tissue damage to produce accelerated radionuclide loss into the blood, and translocation to the skeleton. In man it is postulated that progressive aggregation of low levels of actinide in the liver could also lead to radiation damage and subsequent translocation to critical osteogenic bone surfaces. (auth)

38771 DEPOSITION PATTERNS AND THE TOXICITY OF TRANSURANIUM ELEMENTS IN LUNG. Sanders, C. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 607-15(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Cellular sites of plutonium localization and later redistribution of plutonium in the lung influences the toxicity of inhaled plutonium compounds. The loss of plutonium from macrophages, the death of macrophages, the engulfment of plutonium by the alveolar epithelium and the sequestration of plutonium in foci of fibrosis account for the relatively long retention times for $^{239}PuO_2$ in the lung. The concentration of plutonium in specific cellular elements of the lung, and in subpleural, fibrotic areas of the lung, provides for high radiation dose rates in limited tissue volumes. Such hot spots of alpha irradiation may cause epithelial metaplasia and eventually, alveolo—bronchiolar carcinoma. Such factors may be of great importance when determining the acceptable limits for exposure of man to air-borne plutonium and other transuranic elements. (auth)

38772 AUTORADIOGRAPHIC DETERMINATION OF ALPHA ACTIVITY BY VARIABLE EXPOSURE TO ^{239}Pu AND ^{241}Am IN MOUSE LIVER. Lindenbaum, A.; Russell, J. J. (Argonne National Lab., Ill.). Health Phys.; 22: No. 6, 617-20(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

A quantitative autoradiographic technique for assay of plutonium or americium deposited in animal tissues was tested for linearity in the relationship between photographic exposure time and number of alpha tracks formed. Liver sections were prepared from mice injected intravenously with several polymeric preparations of ^{239}Pu or ^{241}Am, at dose levels ranging from 6.6 to 93 μCi/kg. Exposure times varied between 2 and 42 days, depending on anticipated track concentrations. The normalized data showed a linear increase in the number of countable tracks with increased exposure times. Also, there was generally good agreement between liver burdens determined autoradiographically or radiochemically. These results indicate the reliability of comparisons based on autoradiographic measurement of discretely deposited plutonium or americium in liver (and other tissues) despite wide differences in deposition levels and exposure times. (auth)

38773 SHORT TERM METABOLISM OF ^{241}Am IN THE ADULT BABOON. Rosen, J. C.; Cohen, N.; Wrenn, M. E. (New York Univ., N. Y.). Health Phys.; 22: No. 6, 621-6(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The distribution and retention of ^{241}Am was measured in two adult female baboons after single intravenous injections of ^{241}Am citrate. Retention of ^{241}Am in the whole body, skeleton, and liver was determined by in vivo scintillation measurements of the 60 keV γ-ray. In addition to "specific site" in vivo measurements, serial biopsy samples were obtained to determine the rate of clearance of ^{241}Am from the liver. Clearance of ^{241}Am from the blood was rapid. Less than 1% of the injected dose remained at 48 hr and less than 0.05% remained one month post injection. Greater than 90% of the activity was associated with the plasma fraction. From analysis of daily excreta, 10% of the injected dose was excreted by the end of the first week and 15% by the end of the first month. Approximately 70% was urinary excretion; however, the urine to fecal clearance ratio varied from 0.06 during the first week to greater than 20 at 3 months. Estimates of the effective half-time of americium in the total body from excreta analysis and from in vivo measurements were 274 and 263 days, respectively. Clearance half times from the liver evaluated by in vivo and biopsy analysis were 150 and 154 days, respectively. In vivo measurements over the head showed no detectable clearance from the skull during the same period. The animals were sacrificed at one and three months post-injection. In order of decreasing total activity the major loci were the skeleton, liver, lungs and kidney, which accounted for about 85% of the retained americium. At the end of one month the highest concentration of activity was found in the liver with concentrations decreasing in the order of bone, lung, aorta, kidney and spleen. Among various bones, the concentration of ^{241}Am varied within a factor of 4, being highest in vertebrae. The concentration in the ends of long bones was 2 to 3 times higher than in the shafts. (auth)

38774 METABOLISM OF AMERICIUM IN LACTATING RATS. Hollins, J. G.; Durakovic, A. B. (National Research Council of Canada, Ottawa). Health Phys.; 22: No. 6, 627-31(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The metabolism of ^{241}Am in lactating and control rats was investigated by measurements of whole-body retention and distribution in bones and liver. At the end of lactation, lactating rats contained more americium than controls. The retention of americium by the liver of lactating rats was also higher. In general, the amount of americium in the skeleton did not differ between experimental groups. The results show that the resorption of bone in lactation does not result in a loss of americium and emphasize the importance of resorbing bone surfaces in the incorporation of americium in vivo. (auth)

38775 RETENTION, DISTRIBUTION, DOSE, AND CYTOGENETIC EFFECTS OF ^{241}Am CITRATE IN THE CHINESE

HAMSTER. McKay, L. R.; Brooks, A. L.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 22: No. 6, 633-40(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Chinese hamsters were injected intraperitoneally with 3.3×10^{-2} or 1×10^{-3} μCi ^{241}Am citrate/g body weight and sacrificed at 1, 2, 4, 8, 16, 32, 64, 225 and 360 days post-injection to determine the tissue distribution and to calculate the radiation dose to the liver and bone. After a rapid early clearance, the whole-body retention of the ^{241}Am decreased with an effective half-life of approximately 1000 days. The liver and skeleton contained 50 and 20%, respectively, of the initial body burden at 360 days post-injection. Other animals were injected with 1×10^{-1}, 3×10^{-2}, 1×10^{-2} and 5×10^{-3} μCi ^{241}Am citrate/g body weight; their mean survival times were 36, 91, 138 and 342 days, respectively, with one control death occurring before 400 days. The most frequent pathological alterations noted were bone marrow hypoplasia and biliary and nodular hyperplasia in the liver. Additional hamsters were injected with graded levels of activity from 5×10^{-3} to 6×10^{-7} μCi ^{241}Am citrate/g body weight. These animals were sacrificed at 6, 15, 42, 122 and 362 days post-injection to determine the frequency of metaphase chromosome aberrations in the liver following partial-hepatectomy to stimulate hepatic cell division and administration of colchicine to accumulate cells in metaphase. The frequency of aberrations/cell in the liver increased linearly with cumulative radiation dose with an aberration coefficient of 7.1×10^{-3} aberrations/cell/rad. There was no change in the effectiveness of the dose per rad for producing aberrations over a dose rate range of 0.05 to 10 rads/day. Americium-241 was about 20 times more efficient per rad than protracted ^{144}Ce$-^{144}$Pr exposures in producing chromosome aberrations. (auth)

38776 METABOLISM OF ^{253}Es IN MICE. Parker, H. G.; Wright, S. R.; Low-Beer, A. de G.; Yaeger, D. J. (Univ. of California, Berkeley). Health Phys.; 22: No. 6, 647-51(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The pure alpha emitter ^{253}Es with a half-life of 20.5 days is now available in microgram amounts. The potential for human exposure to it and the lack of published observations on its behavior in animals resulted in a study of its whole-body retention, excretion and organ distribution in mice. Citrated ^{253}Es was injected intramuscularly; half the mice also received DTPA treatment beginning 2 hr after the injection. Daily whole-body counts were obtained by L X-ray counting, and the organ and tissue activities were measured by X-ray and alpha counting at 4 and 14 days. Comparison was made with earlier Am and Cf studies in mice. Einsteinium behaved according to predictions based on its place among the actinides. DTPA therapy was about as effective for Es as for the other actinides. The validity of the L X-ray method for whole-body, organ, tissue and excreta counts, using empirically determined correction factors, was established for the mouse. The method offers simplifications for future studies of this sort. (auth)

38777 PRELIMINARY DATA ON ^{253}Es AND ^{249}Bk METABOLISM IN RATS. Hungate, F. P.; Ballou, J. E.; Mahlum, D. D.; (and others) (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 653-6(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Rats were administered ^{253}Es by intragastric, intratracheal, intravenous, intraperitoneal, transplacental, and transcutaneous routes. Early results from these studies are reported. Data are also reported on the intragastric and intravenous administration of ^{249}Bk. Results are consistent in general form with what would have been predicted from the known behavior of lighter actinides. (auth)

38778 EXPERIMENTAL COMPARATIVE STUDY OF THE BEHAVIOUR OF ^{237}Np, ^{238}Pu, ^{239}Pu, ^{241}Am, AND ^{242}Cm IN BONE. Nenot, J. C.; Masse, R.; Morin, M.; Lafuma, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Health Phys.; 22: No. 6, 657-65(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Actinides, ^{241}Am, ^{242}Cm, ^{237}Np, ^{238}Pu, and ^{239}Pu, whether administered by intramuscular injection or by aerosol, showed different rates of uptake from the contaminated site and resulted in different bone deposits in rats. Neptunium, especially when injected as an acid solution with valence V, had a metabolic fate similar to elements with valence II, yet its urinary excretion was higher than that of the alkaline earths. Because of their valences both curium and americium (valence III) and plutonium (valence IV) could be compared to lanthanides. Following intramuscular injection, ^{238}Pu and ^{239}Pu could be distinguished from americium and curium by a greater uptake in bone. The part played by mass, noticeable after intramuscular injections, was still more noticeable after pulmonary administration. Bone deposits were higher with ^{238}Pu than with ^{239}Pu. A study of the various plutonium compounds or complexes showed that bone burdens decreased as their stability in vivo increased. The smallest bone burden was obtained with the Pu-DTPA complex, the highest one with the Pu-transferrin complex. Bone-seeking actinides could also be distinguished by their histological distribution. Uptake areas were periosteum, perivascular spaces, endosteum, the inner epiphysal plate, metaphysis and marrow. No element seemed to deposit noticeably on the mineral matrix; yet some migrating elements could be found in deep bone, closely connected with the osteocytes and their canaliculi. A rough assessment of actinide bone deposits was obtained quickly by determining the total amount of urinary excretion of the element prior to any medical treatment. Estimating the bone burden to be twice the cumulative urinary excretion before initiating treatment with DTPA would usually overestimate bone deposition, which would not impair the therapeutic decision. DTPA was effective in treating bone deposits of elements of valence III and IV; they were decreased by one third within 3 months. It was not determined whether this action would last beyond the fourth month. (auth)

38779 CALIFORNIUM EXCRETION AND RETENTION BY BEAGLES INJECTED WITH ^{249}Cf OR ^{252}Cf. Lloyd, Ray D.; Mays, Charles W.; Taylor, Glenn N.; Williams, Jerry L. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6, 667-73(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The metabolism of californium was studied in 11 beagles 0 to 160 days after intravenous injection of ^{249}Cf or ^{252}Cf as Cf(III) citrate. Total excreta collections were made for the first 21 days after injection, and the samples were analyzed for their californium content by γ-ray counting of the 333 and 388 keV γ-rays of ^{249}Cf or the fission γ-rays of ^{252}Cf. It was found that the excretion of californium during this period was mainly in the urine. About $^3/_5$ of the total activity excreted during the first 3 weeks appeared in the first day's collection. A combination of total-body and partial-body counting was used to determine serially the total-body retention and partitioning of retained Cf between liver and non-liver tissue. These measurements indicated that 1 week following injection, about 20% of the injected Cf was deposited in the liver and that about 60% remained in non-liver tissue (mainly skeleton). The relative bone-to-bone distribution of ^{249}Cf in the skeletons of 2 dogs sacrificed 7 and 21 days after injection was similar to that of ^{241}Am and ^{239}Pu injected as citrates. (auth)

38780 DISTRIBUTION AND RETENTION OF ^{249}Cf IN BEAGLE SOFT TISSUE. Atherton, David R.; Lloyd, Ray D. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6, 675-7(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Beagles injected intravenously with ^{249}Cf in citrate buffer of pH 3.5 were sacrificed 7 days and 3 weeks after injection. As with americium, the concentration of californium in the liver was highest of all soft tissue but the total was about 18 to 20%, whereas the beagle liver retains about 50% of injected americium at comparable times. Concentrations in other soft tissue ranged from 70% of that in the liver downward. The thyroid, kidney, spleen, lymphatic tissue and dura mater showed significant concentrations. The presence of californium was ubiquitous but in very low concentrations throughout all other soft parts; the brain, lungs, heart, gastrointestinal tract, pancreas, gonads, thymus, pituitary and adrenals being measured specifically, as were large samples of fat, muscle and pelt. From these initial studies it is seen that of the soft tissues, liver, thyroid, and kidneys will be at greatest risk following administration of ^{249}Cf. (auth)

38781 INTERACTION OF ^{249}Cf AND ^{252}Cf WITH CONSTITUENTS OF DOG AND HUMAN BLOOD. Stevens, Walter; Bruenger, F. W. (Univ. of Utah, Salt Lake City). Health Phys.; 22: No. 6, 679-83(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland Wash. (27 Sep 1971). See CONF-710919.

Beagles were injected with ^{249}Cf or ^{252}Cf in citrate buffer. The concentration of nuclide in plasma and whole blood was measured from 5 min to 48 hr post injection. Small amounts of californium were found associated with the cellular elements. The concentration of californium in plasma decreased rapidly during the first few hours after injection. At 24 hr post injection less than 1% of the injected dose was circulating. Californium-249 and -252 disappeared from the circulation at the same rate. Separation of plasma constituents by gel filtration demonstrated that californium in plasma was associated with compounds with a molecular weight of approximately 70,000. Additional information obtained by ion exchange chromatography indicated that this protein was transferrin. Data obtained in vivo from canines were extended by in vitro experiments with human blood. Gel chromatography of human plasma protein incubated in vitro with californium indicated that a Cf-protein complex was formed and appeared to be nearly identical to that seen in dogs. Re-chromatography of these fractions on DEAE-Sephadex showed that transferrin and californium did not coincide exactly. Thus californium-transferrin is either held more tenaciously by the ion exchange resin than iron-transferrin or apo-transferrin, or the shift was caused by the presence of another as yet unidentified minor protein component. The stability of the protein complex(s) formed is less than that of the plutonium-transferrin complex and this decreased stability is responsible for the high rate of its disappearance from the bloodstream. (auth)

38782 INTRACELLULAR DISTRIBUTION OF ^{249}Cf IN CANINE LIVER. Bruenger, F. W.; Atherton, D. R.; Stevens, W. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6, 685-9(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Three beagles were injected intravenously with ^{249}Cf in citrate buffer. One of these dogs was sacrificed at 7 days, another at 21 days; liver biopsies were performed on the third dog starting at one day after injection. Liver specimens from all dogs were homogenized in sucrose-Ca^{++} and subjected to differential centrifugation. Most of the ^{249}Cf was initially bound by soluble proteins, probably ferritin. At later times, increasing quantities were associated with intracellular organelles. Homogenate fractions free of nuclei and debris (homogenate after 6000 g-min) were subjected to centrifugation for 220,000 g-min in a continuous linear sucrose gradient of 12 to 52%. All fractions were collected and analyzed for ^{249}Cf, protein, acid phosphatase (lysosomal marker), and cytochrome c oxidase (mitochondrial marker). At one day after injection more than 50% of the nuclide was found in the three lightest fractions and approximately 10% in the three heaviest fractions. This pattern was reversed with time and at 21 days 10% was found in the lightest fractions and 43% in the heaviest fractions. At this time more than 50% of the nuclide in the liver was associated with the fraction collected at 60,000 g-min, designated as mitochondria. This fraction showed high cytochrome oxidase activity and also acid phosphatase activity. It is presently assumed that redistribution occurs from soluble proteins into mitochondria and then into lysosomes. Similar data were obtained from kidney and spleen homogenates. (auth)

38783 MICROSCOPIC DISTRIBUTION OF ^{249}Cf AND ^{249}Bk IN THE SOFT TISSUES OF BEAGLES. Taylor, G. N.; Jee, W. S. S.; Mays, C. W.; (and others) (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6, 691-3(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The microscopic distribution pattern of ^{249}Cf and ^{249}Bk in the soft tissues of beagles, one to three weeks following a single intravenous injection of a citrate solution, was found to be very similar to that of ^{241}Am. Relatively high concentrations occurred in the hepatic cells of the liver, the glomeruli of the kidney, the interfollicular region of the thyroid, the cartilaginous tissues of the lung, and the media of the smaller arterioles of most organs. Very intense, but sparsely scattered hot spots were also present in the renal papillae and in the submucosa of the bronchioles. Lesser sites of localization were the endocardium of the AV heart valves, the glassy membranes of the larger hairs of the coat, the zona pellucida of the Graafian follicles and the zona arcuata of the adrenal cortex. With the exception of the liver, where the radionuclide was principally within the hepatic cells, most of the deposition sites were extracellular, within or associated with connective tissue which gave a positive periodic acid-Schiff reaction. (auth)

38784 COMPARISON OF THE RETENTION AND DISTRIBUTION OF INJECTED ^{252}Cf IN RATS AND CHINESE HAMSTERS. Mewhinney, J. A.; Brooks, A. L.; McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 22: No. 6, 695-700(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The retentions of ^{252}Cf in the rat and Chinese hamster were compared for 64 days following intraperitoneal injection of the citrate complex. Organ distribution was determined by serial sacrifice of groups of 6 animals at 1, 2, 4, 8, 16, 32 and 64 days post-injection for each species. Comparison of the whole-body retention pattern of ^{252}Cf in the rat and Chinese hamster revealed significant differences. Although whole-body clearance was nearly equal at comparable times post-injection through 64 days, differences were reflected in the number of exponential components needed to adequately describe the data and in the effective half-times of the long-term components of the two equations. For rats, the long-term component was clearly a function of avid skeletal retention whereas the long-term component for Chinese hamster retention was a function of combined liver and skeletal retention. The greater contrasts between the two species were noted in organ distribution and retention. The rat initially deposited much lower quantities in the liver and kidney. Elimination from these organs was characterized by half-times of approximately 5 days. In the Chinese hamster, initial deposition in the kidney and liver was greater than in the rat. The hamster kidney deposition was eliminated much like the rat with a short effective half-time. However, the liver of the hamster retained the initial burden much longer than did the rat liver. (auth)

38785 PLUTONIUM IN THE DEVELOPING ANIMAL. Sikov, M. R.; Mahlum, D. D. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 707-12(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

It is evident that many of the parameters used for calculation of permissible limits of exposure to radionuclides are different for the immature individual than for the adult. The available data on such metabolic parameters of ^{239}Pu in mammals as absorption, partition, and retention were assembled, and distinctive changes in these parameters were found to occur during maturation. Moreover, the radiation sensitivity of individual organs, and of the whole organism, changes during development. The effect of these changes on the selection of the critical organ in the immature animal was examined. (UK)

38786 WHOLE-BODY AUTORADIOGRAPHIC STUDIES ON PLUTONIUM METABOLISM AS AFFECTED BY ITS PHYSICO-CHEMICAL STATE AND ROUTE OF ADMINISTRATION. Matsuoka, O.; Kashima, M.; Joshima, H.; Noda, Y. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 22: No. 6, 713-22(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

A comparative investigation of autoradiograms was carried out on specimens obtained from animals administered monomeric or polymeric forms of plutonium-239. Results were compared with those obtained from animals administered metabolically stable reference particles of known particle size. In addition to whole-body autoradiography and measurements of whole-body retention by counting of L-X rays, blood clearance was also examined, and the modification of plutonium distribution and excretion by DTPA. Following intravenous injection, the blood clearance of plutonium was influenced by particle size. A general rule was proposed relating the size of particles and their behavior in RES organs. The whole-body autoradiographic technique reveals characteristic distribution patterns at early stages following intraperitoneal or subcutaneous injection. The behavior of plutonium soon after administration is largely influenced by its particulate character rather than by its elemental (chemical) nature. The results obtained following inhalation of a plutonium nitrate aerosol showed no obvious translocation of plutonium to the liver, despite the water solubility of the nitrate form. The initial uniform distribution of inhaled plutonium changed to a nonuniform distribution after 3 months. The effectiveness of DTPA treatment was studied in experiments involving injection of premixed Ca-DTPA and plutonium-239, or successive injections of Ca-DTPA to plutonium-239-burdened mice. The effectiveness of treatment was influenced by the physico-chemical state of the plutonium as well as by biological factors. It was demonstrated by diffusion chamber techniques that the chelating action of Ca-DTPA on plutonium colloids depends largely on their degree of polymerization. (auth)

38787 PLUTONIUM DEPOSITION KINETICS IN THE RAT. Durbin, Patricia W.; Horovitz, Mark W.; Close, Elon R. (Univ. of California, Berkeley). Health Phys.; 22: No. 6, 731-41 (Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

A conventional kinetic model was constructed to describe the transport and deposition of intravenously injected Pu(IV) citrate in the rat. A digital computer program (MIMIC) was used to generate numerical solutions to the differential equations representing the compartment model. Tissue data and information on the rate of Pu-protein binding in plasma were drawn from published sources. The model consisted of two blood compartments, unbound Pu (Pu$_f$) and protein-bound Pu (Pu$_b$), assumed to be bound for the most part to the Fe-carrying protein, transferrin (TF); two extracellular fluid (ECF) compartments, Pu$_f$ and Pu$_b$; and four effectively non-returning sinks: liver, skeleton, soft tissues, and excreta. The implications of the solution of the model led to the following working hypotheses: (a) Pu$_f$ reacts with protein, presumably TF, in ECF as well as in plasma. The Pu—TF complex is the most likely form in which diffusible Pu is mobilized from parenteral injection sites, and the most likely form in which orally administered Pu is carried once it reaches the plasma. (b) Little, if any, Pu$_b$ is excreted or deposited in the liver. Formation of the Pu—TF complex is probably not a necessary preliminary to liver deposition of diffusible Pu. (c) Both Pu$_f$ and Pu$_b$ are sources of Pu deposited in bone. The surface of the reticulocyte (where Fe is released from the Fe—TF complex) is considered the most likely site of dissociation of the Pu—TF complex. Pu released at that site could either recombine with TF and recirculate as Pu—TF, effectively prolonging Pu circulation, or recirculate temporarily as Pu$_f$ providing the necessary feedback of Pu$_f$, or diffuse to the most readily accessible bone surface. (auth)

38788 MARROW DEPOSITION AND DISTRIBUTION OF MONOMERIC AND POLYMERIC ^{239}Pu IN THE MOUSE, ESTIMATED BY USE OF ^{59}Fe. Rosenthal, M. W.; Moretti, E.; Russell, J. J.; Lindenbaum, A. (Argonne National Lab., Ill.). Health Phys.; 22: No. 6, 743-8(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Iron-59 was used in mice as a tracer for bone marrow to extrapolate from ^{239}Pu measured in a standard sample of tibial marrow to the ^{239}Pu in total marrow 5 to 6 days after intravenous injection of different physical—chemical forms of plutonium. A factor of 44 was obtained for conversion of the radioactivity measured in the tibial sample to total body marrow. Using this factor, and calculating the total skeletal plutonium burden as the amount measured in two femurs times 13, the proportion of skeletal plutonium located in the marrow was calculated. For monomeric, mid-range polymeric and highly polymeric plutonium, values of 2, 7 to 15 and 62%, respectively, were obtained. Similarly, for monomeric americium and a highly polymeric americium, 1 and 20% of the total skeletal burden was calculated to be in the marrow. In two experiments, in which monomeric plutonium was found to be about twice as carcinogenic in bone as the mid-range polymeric plutonium, the amount of plutonium in all the bones and spinal segments was measured at 15 days. Using these data and the ^{59}Fe measurements, the marrow content of these two forms of plutonium were calculated and tabulated throughout the skeleton. The total marrow burdens, calculated from the tibial samples, were 0.796% of the injected monomeric vs 3.66% of the mid-range polymeric plutonium. These amounts were 2.35 vs 14.3% of the amount of plutonium measured in the total skeleton, respectively. (auth)

38789 HIGH RESOLUTION NEUTRON-INDUCED AUTORADIOGRAPHY OF BONE CONTAINING ^{239}Pu. Jee, W. S. S.; Dell, Rebecca B. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6, 761-3(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The detailed neutron-induced autoradiographic process for bone containing ^{239}Pu produces autoradiographs with both fission fragment tracks and a corresponding bone image. Seven-microns-thick undecalcified bone sections were affixed on 300-μm-thick Lexan (polycarbonate) film coated with 0.5% calf skin gelatin and exposed to neutrons in the thermal column of the Material Testing Reactor (MTR) at the National Reactor Testing Station in Idaho. The specimens were immersed in 28% KOH at 50°C for 1 to 1½ hr to etch pinholes at the location of each fission track and to pit the film at the location of the bone. When the films were etched immediately after irradiation, no bone image was produced, but when the bone sections were allowed to remain on the film for several weeks after irradiation, the irradiated bone caused a pitting of the film surface. Betas from ^{32}P seemed to be the main charged particles available to produce the pitting. This detailed neutron-induced autoradiographic process has advantages over the nuclear emulsion autoradiography of bones because it eliminates long exposure times and fading of latent image. It is a rapid, effective procedure. (auth)

38790 THERAPEUTIC REMOVAL OF INTERNALLY DEPOSITED TRANSURANIUM ELEMENTS. Smith, V. H. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 765-78(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Treatment for the accidental incorporation of the transuranic elements is mainly dependent on chelation therapy. Most of the therapeutic experience was evolved, justifiably, for the removal of plutonium. The plutonium therapeutic regimens may serve as a rough guide to the treatment of other transuranides, although, quantitatively, dissimilarities based on chemical and incorporated mass differences are to be expected. With the added complication of the biological disposition of the daughter products and the high specific activities of some of the isotopes, any significant incorporation should be treated, and treated promptly. While progress in the treatment of plutonium has been slow, a better understanding of removal from specific tissues, such as liver, bone, and lung, for soluble and insoluble plutonium materials, is being achieved. The brightest spot is the ability to remove about half the inhaled particulates, plutonium or other transuranics, from the lung by lung washing. Coupled with the judicious use of chelation therapy this should significantly reduce the hazard from inhaled transuranics. These and other aspects of the treatment for poisoning by the transuranic elements are discussed. (auth)

38791 REMOVAL OF INTERNALLY DEPOSITED TRANSURANIUM ELEMENTS BY Zn—DTPA. Seidel, A.; Volf, V. (Kernforschungszentrum, Karlsruhe, Ger.). Health Phys.; 22: No. 6, 779-83(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The comparative effectiveness of Ca—DTPA and Zn—DTPA in removing internally deposited ^{239}Pu, ^{241}Am and ^{242}Cm was tested in the rat. The radionuclides were administered in a citrate solution and treatment with three chelate injections (1 mmol/kg^{1}/d^{1}) was begun 6 days later. No essential differences were observed between the two chelates tested. The data indicate that the removal of the isotopes from the liver cannot be a suitable criterion for the effectiveness of treatment in other soft tissue organs. The liver isotope content was reduced to 10% of the controls, whereas the content of other organs, including bone, was never reduced to less than 40% of the control. In liver and lung, the response to treatment was different for ^{241}Am and ^{242}Cm as compared to ^{239}Pu. There was no such difference as far as other organs are concerned. (auth)

38792 GASTROINTESTINAL ABSORPTION AND RETENTION OF PLUTONIUM CHELATES. Baxter, D. W.; Sullivan, M. F. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 785-6(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The intestinal absorption of plutonium nitrate is increased approximately 700-fold when chelated with DTPA. Within two days, virtually all of the absorbed plutonium—DTPA complex was excreted in the urine of rats. Thus, plutonium retention in the liver and skeleton is quite low, but more than twice as high as when DTPA is not present. Citrate is less effective than DTPA in increasing absorption, but more effective in increasing retention. Since both absorption and retention are increased by chelation, consideration must be given to this added risk when therapeutic procedures result in the chelation of plutonium entering the GI tract. (auth)

38793 PROGRESS IN THE BEAGLE STUDIES AT THE UNIVERSITY OF UTAH. Mays, C. W.; Dougherty, T. F. (Univ. of Utah, Salt Lake City). Contract AT(11-1)-119. Health Phys.; 22: No. 6, 793-801(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Young adult beagles are given single intravenous injections of monomeric ^{252}Cf, ^{249}Cf, ^{241}Am, ^{239}Pu, ^{228}Th, ^{228}Ra, ^{226}Ra or ^{90}Sr in citrate solution to achieve reproducible deposition patterns in tissue. Injected transuranium atoms become attached to transferrin and other substances in blood plasma. The skeleton and liver are the primary sites of deposition, although high local concentrations of californium, berkelium and americium also occur in the thyroid and kidney, and radium also concentrates in the eye. The initial skeletal deposition of monomeric transuranium elements is on bone surfaces. The mean local dose-rate to the soft-tissue layer 0 to 10 μ from the mineralized bone surfaces of the beagle is about 20 times higher when ^{239}Pu is on bone surfaces than for an equal amount of ^{239}Pu randomly distributed throughout the bone mineral. Thus, the rate of bone-surface remodeling has a very important influence on the skeletal toxicity of the transuranium elements. The initial liver deposition of monomeric transuranium elements is rather uniform and mainly in the hepatic cells. Subsequently, much of the radioactivity shifts into the liver reticulo-endothelial cells that line the sinusoids. A long time after injection, the distribution is very non-uniform, being highest in the portal region and lowest in the regenerative nodules. All, or virtually all, of the life-shortening from medium and low doses was due to radiation-induced cancer. Bone sarcomas were the most frequent form of malignancy, but head sinus carcinomas, liver tumors, and eye melanomas were also induced. On the basis of average skeletal dose, 1 rad from ^{239}Pu is the equivalent of 5 to 10 rads from ^{226}Ra in the induction of bone sarcomas. This is because in the skeleton a considerable fraction of the ^{239}Pu disintegrations occur on bone surfaces near cells, whereas most of the skeletal disintegrations from ^{226}Ra take place within bone mineral. (auth)

38794 PROGRESS IN THE BEAGLE STUDIES AT COLORADO STATE UNIVERSITY. Watters, Robert L.; Lebel, Jacques L. (Colorado State Univ., Ft. Collins). Contract AT(11-1)-1787. Health Phys ; 22: No. 6, 811-14(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Air oxidized plutonium, ^{239}Pu(NO$_3$)$_4$ and high fired ^{239}PuO$_2$ (850°C) with known amounts of ^{241}Am were implanted over the left metacarpus in beagle dogs and the concentrations of ^{239}Pu and ^{241}Am in various tissues were measured as a function of time. The effect of DTPA therapy upon organ depositions was also studied. For air oxidized plutonium, rapid movement of ^{239}Pu and ^{241}Am to the proximal lymph node (superficial cervical) was observed by in vivo counting. Approximately 3% of the implant material reached the lymph node within 2 weeks and continued an exponential build-up to 17% at 1 yr. Results of plutonium assays in blood indicate a 14-fold increase in movement to the circulation from the Pu(NO$_3$)$_4$ implants as compared with the air oxidized plutonium. This is supported by comparison of the depositions in the liver and the proximal end of the femur where the Pu(NO$_3$)$_4$ experiment produced twenty-four times higher levels of plutonium than did the air oxidized plutonium experiment. The effect of DTPA therapy was greater for the nitrate than for the air oxidized plutonium implants. (auth)

38795 PROGRESS IN STUDIES WITH TRANSURANIC ELEMENTS AT THE LOVELACE FOUNDATION. McClellan, R. O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 22: No. 6, 815-22(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Research directed toward developing an improved understanding of the biomedical consequences of inhaling transuranic elements was initiated at the Lovelace Foundation in 1968, recognizing the need for additional information on these radionuclides as well as the opportunity to obtain data for comparison with those previously collected and being collected on fission product radionuclides. The research is being performed to develop information that will assist in predicting potential effects in man from inhaled transuranic elements, and to provide the data necessary for establishing realistic radiation protection guides. Recognizing the need for quantitative data on the influence of particle size on the toxicity of inhaled alpha emitters, a major, and successful, effort was directed toward the production of monodisperse aerosols of respirable particles. Studies on the metabolism and toxicity of ^{239}Pu, ^{241}Am, ^{244}Cm and ^{252}Cf were performed or are under way in mice, Chinese hamsters, Syrian hamsters, rats and Beagle dogs. The effectiveness of bronchopulmonary lavage for removing inhaled radioactivity, including ^{239}Pu, is also being studied. This study, in part, provided the basis for the use of bronchopulmonary lavage to treat an individual who accidentally inhaled ^{239}Pu. (auth)

38796 STUDY OF TRANSLOCATION DYNAMICS OF PLUTONIUM AND AMERICIUM FROM SIMULATED PUNCTURE WOUNDS IN BEAGLE DOGS. Bistline, R. W.; Watters, R. L.; Lebel, J. L. (Colorado State Univ., Ft. Collins). Contract AT(11-1)-1787. Health Phys.; 22: No. 6, 829-31(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The translocation dynamics of ^{239}Pu and ^{241}Am from simulated wounds contaminated with Pu(NO$_3$)$_4$ and high fired PuO$_2$ (calcined at 850°C) in the paw of dogs were analyzed by in vivo counting equipment. Measurements were made over the implant site and the major superficial cervical lymph node with a NaI(Tl) detector system. The difference in accumulation dynamics between the two chemical forms and effects of DTPA treatment are shown. In all cases, measurable levels of plutonium movement to this lymph node were seen within minutes. (auth)

38797 EFFECT OF LYMPH NODE REMOVAL ON PuO$_2$ TRANSLOCATION. Gomez, L. S.; Lebel, J. L.; Watters, R. L. (Colorado State Univ., Ft. Collins). Contract AT(11-1)-1787. Health Phys.; 22: No. 6, 833-6(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The translocation of high-fired ^{239}PuO$_2$ via the lymphatic system from a simulated puncture wound in the left dorsal metacarpus of beagle dogs was studied. Comparisons were made between dogs with and without excision of the left superficial cervical lymph node. Accumulation of plutonium in the lymph node was determined by counting the low-energy x-ray complex with a thin NaI (Tl) detector. The dogs were killed less than 2 weeks after implant and the activity determined for selected tissues. Higher levels of plutonium were found in the liver, spleen and hepatic lymph nodes of lymphadenectomized dogs than in the intact dogs. Implications of these data with regard to therapeutic lymph node removal for workers contaminated with plutonium are discussed. (auth)

38798 ALVEOLAR DEPOSITION OF ^{239}PuO$_2$ AEROSOLS IN BEAGLE DOGS AS A FUNCTION OF RESPIRATION AND AEROSOL PARAMETERS. Craig, D. K.; Thomas, J. M.; Decker, J. R.; Park, J. F. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys.; 22: No. 6, 845-55(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Beagle dogs were exposed to ^{239}PuO$_2$ aerosols as part of a low-level effects study. Desired alveolar burdens ranged from 2 nCi to 3 μCi, divided into 6 groups. Respiration parameters measured during exposure included total inspired volume (VOL), respiratory frequency (RR) and tidal volume (TV). Aerosol parameters measured were concentration (CONC) and the aerodynamic equivalent size distribution, characterized by the activity median aerodynamic diameter (AMAD) and geometric standard deviation (GSD). These latter two measures were combined into one parameter, percentage activity less than 0.5 μm aerodynamic equivalent diameter (LS 0.5), to describe the aerosol size distribution. Alveolar deposition (NCI) was determined from thorax counts 14 days post exposure. Percentage alveolar deposition, defined as DEP = (100 × NCI)/(VOL × CONC), varied from 0 to 54 for 36 exposed dogs. A correlation matrix involving aerosol, respiration and physiologic (WT) parameters was computed to determine those factors which most significantly influenced DEP. Subsequent stepwise regression analysis yielded the equation DEP = 3.11 LS 0.5 + 0.015 TV, which accounted for 74% of the variability in DEP. Unlike tidal volume, respiration rate was not significantly correlated with DEP. AMAD was found to be highly correlated with LOG$_{10}$ CONC (R = 0.895) while GSD was significantly correlated with AMAD (R = −0.597). This suggested that the pre-exposure value of CONC could be used indirectly to compute LS 0.5. Since an estimate of TV could also be obtained during the exposure, DEP values could be estimated from the suggested regression equation, and the volume (VOL) that a dog should inhale to obtain the required alveolar burden (NCI) could be calculated. The results obtained using this procedure are discussed. (auth)

38799 METABOLIC EQUIVALENCE OF INGESTED, INJECTED, AND INHALED ^{239}Pu CITRATE. Ballou, J. E.; Park, J. F.; Morrow, W. G. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys ; 22: No. 6, 857-62(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Dogs administered oral, intravenous, or inhaled ^{239}Pu citrate were sacrificed from one to 100 days after exposure to compare distribution and retention kinetics. Approximately 0.08% of the oral dose was retained after 3 days, distributed mainly between skeleton (50%) and liver (25%). After intravenous administration ^{239}Pu was retained principally in the liver (32 to 45% of the dose) and skeleton (29% of the dose) during the 100 day post injection period. Inhaled ^{239}Pu reached a peak concentration in blood after 6 hr and then decreased with clearance kinetics similar to those described by others for dogs and humans administered intravenous ^{239}Pu citrate. The lung, skeleton, liver, blood, and intestines retained most of the inhaled ^{239}Pu one day after exposure. After 100 days 36% of the initial deposit was retained; 33% of that retained was in the lung, 44% in the skeleton and 17% in the liver. Plutonium was concentrated by lymphatic tissue following all methods of administration at all time intervals. Although the concentration in specific lymph nodes (hepatic, splenic, and tracheobronchial) was among the highest of any tissue analyzed, the total amount deposited in a selection of 12 lymph nodes (~10 g tissue) was always less than 0.6% of the body burden. (auth)

38800 RETENTION AND DISTRIBUTION OF ^{244}Cm FOLLOWING INHALATION OF ^{244}CmCl$_3$ AND ^{244}CmO$_{1.73}$ BY BEAGLE DOGS. McClellan, R. O.; Body, H. A.; Gallegos, A. F.; Thomas, R. G. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Health Phys.; 22: No. 6, 877-85(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

Twenty-four Beagle dogs were exposed to aerosols of ^{244}CmCl$_3$–CsCl (AMAD ~ 1.6 μm) or ^{244}CmO$_{1.73}$ (AMAD ~ 0.5 μm) and sacrificed at 0.1, 2, 8, 16, 64, 128 or 256 days post-inhalation exposure. Total body deposition was greatest for the dogs exposed to the aerosol with the larger AMAD (64 vs 35%). Lung deposition was only slightly greater for the dogs exposed to the aerosol with the largest AMAD (33 vs 27%). Curium-244 not deposited in the lungs was cleared rapidly via the feces. Urinary clearance of ^{244}Cm was similar for dogs exposed to the two forms of aerosol. Likewise, the tissue retention pattern was generally similar for the two aerosols with ^{244}Cm being translocated relatively rapidly from lung to skeleton and liver such that by 256 days post-inhalation exposure lung, liver and skeleton contained ≈3%, ≈30% and ≈45%, respectively, of the initial lung burden. The similar metabolic behavior of the two forms of inhaled ^{244}Cm with relatively rapid translocation from lung to skeleton and liver contrasts sharply with the metabolic behavior of several forms of inhaled Pu which were retained more tenaciously in lung with distinct differences in lung retention related to the form of Pu inhaled. These differences strongly indicate the need to base radiation protection guides for Cm on actual Cm metabolic data and suggest that the establishment of guides for Cm based on extrapolation from Pu metabolic data may be inappropriate. (auth)

38801 COUNTING PLUTONIUM IN THE TRACHEOBRONCHIAL LYMPH NODES. Swinth, K. L. (Battelle-Northwest, Richland, Wash.); Park, J. F.; Moldofsky, P. J. Contract AT-(45-10)-1830. Health Phys.; 22: No. 6, 899-904(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

A series of intraesophageal probes containing avalanche diode detectors were developed for detecting plutonium translocated to the tracheobronchial lymph nodes. Experiments with dogs having body burdens of plutonium yielded an average sensitivity of 67 cpm/μCi for the middle tracheobronchial node and 124 cpm/μCi for the right tracheobronchial node. Experiments with a human thoracic phantom resulted in sensitivities of 30 to 60 cpm/μCi for the middle tracheobronchial node. Two standard deviations of the background for a 20 min count correspond to 8 nCi under optimum counting conditions with the phantom. (auth)

Plants

Refer also to abstract 38300.

38802 (AEC-tr-7306, pp 241-4) ACCUMULATION OF ^{234}Th BY SEAWEED. Nazarov, A. B.; Zesenko, A. Ya. (Inst. of Biology of the Southern Seas, Sevastopol). Translated from Radiobiologiya; 11: No. 5, 799-801(Sep-Oct 1971).

The dynamics of thorium-234 accumulation by the marine algae Ulva rigida and Cystoseira barbata was studied under experimental conditions. The accumulation coefficients were highest after three days, 1200 and 60, respectively. The results are discussed from the standpoint of the participation of marine organisms in the shifting of the radioactive uranium-238/thorium-234 balance in the ocean. (tr-auth)

38803 RADIOACTIVITY LEVELS IN SOME LICHENS. Cigna Rossi, L. (CNEN—CSN, Casaccia, Italy). Minerva Fisiconucl.; 15: No. 3, 124-30(Jul-Sep 1971). (In Italian).

The results of measurements of ^{54}Mn, ^{90}Sr, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce and Ca concentrations in some species of lichens and corresponding substrata collected in Italy in the period 1961 to 1969 are here reported. Important concentration processes were not detected and the radioactive contamination seems to be assumed by surface absorption. Only for ^{90}Sr a selective concentration mechanism seems to exist. The results are compared with others obtained from samples collected in different regions of the world. (auth)

38804 INCREASED UPTAKE OF ^{241}Am BY PLANTS CAUSED BY THE CHELATING AGENT DTPA. Wallace, Arthur (Univ. of California, Los Angeles). Contracts AT(04-3)34 PA-51; AT(04-1)-Gen-12. Health Phys.; 22: No. 6, 559-62(Jun 1972).

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971). See CONF-710919.

The chelating agent diethylenetriaminepentaacetic acid (DTPA) which has the ability to increase uptake by plants of several metals and is widely used as a practical means of correcting iron deficiency in plants was shown to greatly increase the uptake from soils of ^{241}Am by plants. Application of high levels of zinc or manganese salts decreased ^{241}Am content of plants only slightly, indicating little, if any, competing effect. Most accumulated ^{241}Am was transported to leaves of all species studied. The ability of plants to accumulate ^{241}Am was not related to root temperature. During a subsequent growth period after applications of ^{241}Am to bush beans, some of the ^{241}Am was transported from the old leaves to the new leaves and also to new roots. The chelating agent DTPA had no effect on the retranslocation, however. Extraction studies with soil indicated that DTPA, but not EDDHA, could quantitatively extract ^{241}Am from soil. (auth)

New Tracer Techniques

Refer also to abstracts 38677 and 38789.

38805 (COO-2031-3) RADIOPHARMACEUTICALS FOR DIAGNOSIS AND TREATMENT. Progress Report. Beierwaltes, William H. (Michigan Univ., Ann Arbor. Dept. of Internal Medicine). 29 Feb 1972. Contract AT(11-1)-2031. 18p. Dep. NTIS.

Research on the development of radiopharmaceuticals for use in diagnosis and therapy is reported. The diagnostic effectiveness of ^{125}I-labeled chloroquine analog for ocular melanotic melanomas and the therapeutic effectiveness of ^{131}I-labeled chloroquine analog for metastatic melanotic melanomas were evaluated. The tissue distribution of ^{125}I-labeled iodopropamide in hamsters and of ^{14}C- or ^{3}H-labeled streptozotocin in dogs and toadfish was determined. Research and labeled precursors included synthesis of ^{11}C-labeled dopamine and the uptake and elimination of ^{131}I-labeled 19-iodocholesterol by the adrenal glands, liver, and spleen. The uptake of ^{131}I-labeled human chorionic gonadotropic hormone by mouse ovarian carcinomas was determined and the antibody to human choriocarcinoma was further characterized. Research on the selective and tight binding of labeled competitive enzyme inhibitors to the active sites of enzymes included the binding of ^{14}C-labeled isoxazole to the active sites of dehydrogenases and isomerases in breast and ovarian carcinomas and the binding of ^{125}I-labeled trasylol to the active sites of proteolytic enzymes in the pancreas. (E.R.B.)

38806 CHELATED RADIOISOTOPE SOLUTIONS. Grotenhuis, Ivan Merle (to Minnesota Mining and Mfg. Co.). British Patent 1,273,446. 10 May 1972. Priority date 26 Jun 1968, United States.

A composition for safely studying functioning and condition of the kidneys and brain contains a chelate of ^{169}Yb having a stability constant of 10^{15} to 10^{20} and soluble in both water and body fluids. Suitable chelating agents are diethylenetriaminepentaacetic acid and ethylenediaminetetraacetic acid. (B.L.M.)

38807 ASSAY OF CHOLESTEROL SULFATE IN BIOLOGICAL MATERIAL BY ENZYMATIC RADIOISOTOPIC DISPLACEMENT. Bleau, G.; Chapdelaine, A.; Roberts, K. D. (Univ. of Montreal. Maisonneuve Hospital, Montreal). Can. J. Biochem.; 50: No. 3, 277-86(Mar 1972).

A technique is described for the measurement of cholesterol sulfate (CS) that is based upon the displacement of labeled CS from a placental sulfatase enzyme system by the addition of unlabeled CS isolated from various biological sources. From the extent of this displacement by unknown samples of CS and by reference to standard curves, the concentration of CS in the biological samples can be calculated. This assay method is relatively simple, rapid, and sensitive (nanogram level) and provides values which are in good agreement with those obtained by a double isotope derivative assay. Levels of CS in human plasma, erythrocytes, semen, and saliva have been determined. This sterol sulfate appears to be a ubiquitous entity although its biological function remains to be determined. Certain aspects of its possible physiological role in the organism are discussed. (auth)

38808 BLOOD ^{131}I AND ^{3}H CURVES FOLLOWING THE SIMULTANEOUS ORAL ADMINISTRATION OF LABELLED MIT AND TYROSINE. Cionini, L.; Becciolini, A. (Univ., Florence). Minerva Fisiconucl.; 15: No. 3, 120-3(Jul-Sep 1971). (In Italian).

Blood ^{131}I and ^{3}H appearance curves following the simultaneous oral administration of ^{131}I-labeled monoiodotyrosine and ^{3}H-labeled tyrosine are presented. The data observed are discussed with reference to the reliability of the stool test for the evaluation of intestinal uptake of ^{131}I-albumin. (auth)

38809 HEMATOPOIETIC AND GASTROINTESTINAL INVESTIGATIONS WITH RADIONUCLIDES. Third Annual Nuclear Medicine Seminar, Miami, Florida, March 3–7, 1971. Gilson, Albert J.; Smoak III, William M.; Weinstein, Morton B. (eds.). Springfield, Ill.; Charles C Thomas, Publisher (1972). 468p. $30.00. (CONF-710349).

Separate abstracts were prepared for 4 of the 44 papers in this seminar. The remaining ones, which were not within the subject scope of NSA, were grouped into the following sections: fundamentals, radionuclides and radiopharmaceuticals, radioisotope therapy in hematology, approaches to pathophysiology, work in process, pancreas, liver and spleen, and a panel discussion on bone marrow imaging in clinical practice. (R.W.R.)

For abstracts of individual chapters see: 38151, 38478, 38512, and 40069.

MATERIALS

Ceramics and Cermets

Refer also to abstracts 38126, 38217, 38219, 38347, 38366, 38584, 38896, 38897, 38908, 38911, 38939, 38941, 38951, 40135, 40224, 40225, 40429, and 40430.

38810 (BMI–1924) EARLY DEVELOPMENT STUDIES ON THE FABRICATION OF UN AND $(U_{0.8}Pu_{0.2})N$ BY SINTERING (1966–1969). Speidel, Edward O.; Smith, Roy A.; Kizer, Donald E. (Battelle Columbus Labs., Ohio). May 1972. Contract W-7405-eng-92. 44p. Dep. NTIS.

Uranium mononitride bodies having densities of 95% of theoretical were obtained by reducing the UN particle size to 1 to 2 μ by ball milling and sintering for 3 hr at temperatures of 1800°C, or above, in nitrogen. At temperatures below which significant decomposition of UN occurs, sintering in vacuum was found to provide greater densification than sintering in either argon or nitrogen. Sintering studies on $(U_{0.8}Pu_{0.2})N$ were conducted using both mechanically mixed and prealloyed powders. Mechanically mixed powders showed a resistance to sintering densification, for the maximum sintered densities obtained approached only 88% of theoretical. A Kirkendall effect was noted in the mechanically mixed powders which accounted for the poor sinterability. Prealloyed powders consistently sintered to between 93.0 and 96.3% of theoretical in 3 hr at 1900°C. Surface oxidation of prealloyed powders during storage was found to have a pronounced effect on sintered density; slight surface oxidation decreased sintered density while oxygen contamination in the range of 5000 to 7000 ppM resulted in enhanced densification. (auth)

38811 (BNWL-tr–69) REFLECTIONS ON FISSION GAS DIFFUSION FROM POROUS SINTER SUBSTANCES. Exner, H. E.; Moench, S.; Petzow, G.; Lukas, H. L. Translated for Battelle Pacific Northwest Labs., Richland, Wash., from J. Nucl. Mater.; 43: 8-12(1972). 8p. Dep. NTIS.

Using a simple model, the conditions for stationary diffusion of fission gases to open pores in porous reactor materials are quantitatively formulated. It is shown that in reactors with high fluxes the fission gases are able to escape from fuel elements with a surface temperature of 1200°C if the pore distances are similar to those obtained under normal sintering conditions. In porous uranium phosphide with 18% open porosity there is no danger of swelling caused by fission gases even at high fuel burn up. (auth)

38812 (CONF-720525–1) DESINTERING OF THORIA. Morgan, C. S.; McCorkle, K. H. (Oak Ridge National Lab., Tenn.); Powell, G. L. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 1972. 17p. Dep. NTIS.

From seventy-fourth annual meeting of the American Ceramic Society; Washington, D. C. (6 May 1972).

Sintered ThO_2 powder compacts will sometimes undergo a density loss and become more porous if held at high temperature for a sufficient time. ThO_2 sol gel sintered to 99% of theoretical density (TD) at 1200°C will undergo a steady bulk density decrease at 1800°C with the density falling below 90% TD after about 15 hours. Results of gas release measurements from desintered ThO_2 specimens annealed in air or in vacuum indicate that gases move through the material freely at 1800°C, suggesting that loss of density may not be a gas pressure effect. The extent of desintering was decreased by firing in argon and vacuum and by the addition of small quantities of other oxides. (auth)

38813 (CONF-720609–3) FABRICATION AND IRRADIATION BEHAVIOR OF ADVANCED FUEL STICKS FOR THE HTGR. Scott, J. L.; Pollock, C. B.; Hamner, R. L.; Robbins, J. M.; Coobs J. H.; Eatherly, W. P. (Oak Ridge National Lab., Tenn.). [1971]. 6p. Dep. NTIS.

From International carbon conference; Baden-Baden, Germany (26 Jun 1972).

Development work and current research on fuel sticks for the HTGR are reviewed. Results of irradiation testing of conventional HTGR fuel sticks have verified their excellent irradiation behavior and clarified desirable properties of the coated particles used in making the sticks. A variety of coated particles and fuel sticks which are more amenable to ^{233}U recycle than those made by present-day technology have been successfully fabricated. Two particularly attractive fuels are sol-gel oxides or resin-derived kernels. With optimum coating design particle loadings less than 62% can be used. New processes for fabricating such sticks containing 30 vol % particles have been developed. (auth)

38814 (EIR–207) PLUTONIUM FUEL PROGRAM. Annual Report, 1971. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Apr 1972. 123p. (In German). Dep. NTIS (U. S. Sales Only).

In addition to the introduction, four aspects of the Swiss plutonium program are presented. Under Sol-Gel procedures are treated: production of UO_2-sols; studies on sol-solvent boundaries; production of $Pu-UO_2-C$ microspheres (150 μm); and internal precipitation from solutions. Discussions of carbides are included on carbothermal reduction; characterization; phase studies; and compatibility experiments. The irradiation facility FILOS is described along with irradiation experiments in FILOS; data evaluation, and vibration compacting. New chemical methods are reported; also discussed are computer software; x–y positioning system, and interface to the HP computer 2116B. Studies of the first FILOS element are also discussed. (H.B.G.)

38815 (GEAP–12269) FISSION GAS RE-SOLUTION RATES. Quarterly Report No. 6, October 1–December 31, 1971. Marlowe, M. O. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Jan 1972. Contract AT(04-3)-189. 20p. Dep. NTIS.

Progress is reported in an experimental program to determine the re-solution rates of fission gases in oxide nuclear fuels under irradiation. Transmission electron microscopy of specimens annealed at 1600°C after irradiation is presented. Characterizations of the fission bubble size distributions after annealing, are discussed including the nature of the size distributions (log-normal), size distribution parameters, volume mean diameters, average number of gas atoms per bubble, bubble density, volume of the bubbles, and total gas contained in bubbles per unit volume. (auth)

38816 (GEAP–12293) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 18, November 1, 1971–January 31, 1972. Aitken, E. A.; Dutina, D.; Adamson, M. G.; Evans, S. K.; Ludlow, T. E. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Jan 1972. Contract AT(04-3)-189. 20p. Dep. NTIS.

Work progress is reported on the continuing scope of work related to vaporization of plutonia-urania, oxygen redistribution in a temperature gradient, Pu/U segregation, sodium-fuel chemical interactions, and fission product-cladding interactions. (auth)

38817 (HEDL-SA–337) OXIDE FUEL RELOCATION BY VAPOR TRANSPORT KINETIC EFFECTS ON THERMAL PERFORMANCE. Hinman, C. A.; Christensen, J. A. (Hanford Engineering Development Lab., Richland, Wash.). 10 Apr 1972. Contract AT(45-1)-2170. 14p. (CONF-720525–3). Dep. NTIS.

From seventy-fourth annual meeting of the American Ceramic Society; Washington, D. C. (6 May 1972).

Vapor phase transport mechanisms which appear capable of affecting the thermal performance of mixed oxide fuels in fast reactor operation were investigated. Results show that fuel material is redistributed by vapor phase transport in fuel element central voids. It appears that if the central void is formed early enough in the fuel element life, axial transport of fissile material can contribute to increase in fuel element power production. (J.R.D.)

38818 (HEDL-TME–71-28) HIGH-TEMPERATURE CREEP OF UO_2–20 WT. PERCENT PuO_2. Slagle, O. D. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contract AT(45-1)-2170. 28p. Dep. NTIS.

The high-temperature creep of UO_2-20 wt % PuO_2 was measured from 1400 to 1575°C in four-point bending. Creep rates were determined for samples with densities of 91 and 96% theoretical density and O/M ratios of 1.98. Activation energies were determined in the range of 110 to 145 kcal. The dependence of strain rate on stress was found to be fit by a power law with stress exponent which ranged from 1.6 to 2.3. Difficulties in obtaining reproducible strain rates as a function of stress are discussed. The results for the mixed-oxide were compared with data obtained for UO_2 samples of similar grain size and density. (auth)

38819 (KFK–1598) BIBLIOGRAPHY ON CERMETS (1945–1971). Jesse, Andreas (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). May 1972. 249p. Dep. NTIS (U. S. Sales Only).

References (3000) on two-phase cermets are given to books, journals, reports, and patents. The arrangement is chronological (1945 to 1971) and alphabetical (first author), respectively. An author index and a detailed subject index are included. The subject index lists the contents of every reference by means of descriptor strings with logic structure. The thesaurus of descriptors comprises the following fields: material(s), technology, properties, applications, and bibliographic information. The distribution of the number of references with time, the main fields of application, and some basic problems related to the research and development of cermets are discussed briefly. (auth)

38820 (LA-DC-72-523) EFFECT OF NEUTRON SPECTRA ON THE SWELLING OF CERAMIC INSULATORS AND IMPLICATIONS FOR THERMIONIC REACTOR DESIGN. Frank, T. G.; Backus, C. E. (Los Alamos Scientific Lab., N. Mex.). [1971]. 22p. (CONF-720613-1). Dep. NTIS.

From third international conference on thermionic electrical power generation; Julich, Germany (5 Jun 1972).

Data on swelling and loss of vacuum integrity of alumina due to neutron irradiation are now available for several neutron spectra. A neutron-energy-dependent model for predicting relative numbers of neutron-induced atomic displacements in alumina in different neutron spectra is presented which correlates the available swelling data reasonably well. The model is extended to yttria and magnesia. It is shown that neutron fluence ($E_n > 0.1$ MeV) is an adequate parameter for use in practical applications for predicting relative numbers of neutron-induced atomic displacements in each of the three materials. The implications of neutron-induced damage to ceramic insulators for thermionic reactor design are discussed, and core designs optimized for minimum neutron damage to in-core ceramic insulators at constant core electric power density are described. (auth)

38821 (LA-DC-72-535) EFFECT OF FAST NEUTRON IRRADIATION ON ALUMINA AND YTTRIA. Ranken, W. A.; Frank, T. G.; Keilholtz, G. W. (Los Alamos Scientific Lab., N. Mex.). [1971]. 19p. (CONF-720613-2). Dep. NTIS.

From third international conference on thermionic electrical power generation; Julich, Germany (5 Jun 1972).

Thin-walled and solid cylinders of commercially available alumina as well as thin-walled cylinders of yttria have been irradiated in the Experimental Breeder Reactor to a maximum fast-neutron ($E_n > 0.1$ MeV) fluence of 9.8×10^{21} n/cm^2 at temperatures ranging from 500 to 1200°K. Macroscopic volume changes as large as 10.5% at 7×10^{21} n/cm^2 were observed for alumina specimens containing silica and calcia in the grain boundaries. However, specimens with high purity and small grain size exhibited about two-thirds less swelling at the same fluence. Modulus-of-elasticity and vacuum-integrity determinations indicate that for a volume increase of 3% the modulus decreases by almost 50% and the probability of vacuum leakage is high. Yttria specimens of both 4 and 40 μm average grain size suffered no dimensional increase and no apparent change in the modulus of elasticity. The results are discussed in terms of their significance to thermionic reactor design. (auth)

38822 (LA-DC-72-552) BEHAVIOR OF TUNGSTEN-CLAD Mo-UO_2 FUEL UNDER NEUTRON IRRADIATION AT HIGH TEMPERATURE. Ranken, W. A.; Reichelt, W. H. (Los Alamos Scientific Lab., N. Mex.). [1970]. 25p. (CONF-720613-3). Dep. NTIS.

From third international conference on thermionic electrical power generation; Julich, Germany (5 Jun 1972).

Specimens of Mo 40 vol % UO_2 cermet reactor fuel, lightly clad with CVD tungsten, have been irradiated for times varying from 2300 to 10,400 h at temperatures of 1700 to 2140°K. Fission-power densities in the fuel varied from 216 to 365 W/cm^3. Maximum burnup was 3.6×10^{20} fissions/cm^3 of cermet. Measurements of dimensional change occurring as a result of irradiation show that dimensional stability is increased by constructing the cermet so that interconnected porosity exists throughout the specimen. The rate of diametral increase of porous cermet specimens was ~1.6% per 10^{20} fissions/cm^3 at 1950°K, but decreased markedly with decreasing temperature. Extensive measurements were made to determine the location of gaseous fission products subsequent to irradiation. These included direct measurements of fission-gas release and measurements of the amount of fission gas retained in both the molybdenum and UO_2 phases of the cermet. Krypton-85 and ^{137}Cs release functions as high as 80% were observed. Scanning-electron-microscope observations indicate that fission gas introduced into the molybdenum phase by recoil collects in bubbles up to 0.8 μm in diameter. The percentage release from the molybdenum phase is small. The data are discussed in terms of the applicability of the cermet fuel form to thermionic emitter construction. (auth)

38823 (LA-DC-72-602) EFFECTS OF SELF-IRRADIATION ON THE LATTICE OF (80%) $^{238}PuO_2$. [PART] II. Roof, R. B. Jr. (Los Alamos Scientific Lab., N. Mex.). [1971]. 5p. (CONF-720801-1). Dep. NTIS.

For Presentation at applications of x-ray analysis conference; Denver, CO. (2 Aug 1972).

The results of the third year of observations on the effects of self-irradiation on the lattice of 238(80%) PuO_2 indicated a small but definite trend towards a reduction in the lattice parameter of this material. The lattice parameter increased from 5.41408 ± 6 Å at 5 weeks to 5.41636 ± 38 to 114 weeks and then decreased to 5.41364 ± 23 noted in the half-widths of the diffraction lines. For the 622 reflection the half-width increased from 0.283 ± 14°2θ at 5 weeks to 0.711 ± 90 at 114 weeks and then decreased to 0.660 ± 89 at 157 weeks. (auth)

38824 (MLM-1925) SIMPLE METHOD FOR THE DETERMINATION OF THE MOLYBDENUM CONCENTRATION OF MOLYBDENUM-COATED PLUTONIUM DIOXIDE PARTICLES. Etter, D. E.; Deaton, R. L. (Mound Lab., Miamisburg, Ohio). 2 Jun 1972. Contract AT-33-1-GEN-53. 9p. Dep. NTIS.

A simple technique for the determination of the molybdenum content of molybdenum-coated plutonium dioxide particles has been devised. This technique utilizes the oxidation of molybdenum metal and the decomposition of a plutonium—molybdenum—oxygen ternary complex to determine the molybdenum content. (auth)

38825 OXIDATION BEHAVIOR OF Mo + ZrO_2 CERMETS. Heitzinger, F. (Metallwerk Plansee, Reutte/Tyrol, Austria). Planseeber. Pulvermet.; 19: No. 3, 169-78(Sep 1971). (In German).

The oxidation behavior of Mo + ZrO_2-cermets is described briefly. Below the melting point of MoO_3, the dispersed zirconia markedly increases the oxidation rate. Above this melting point, the entire oxidation characteristics of molybdenum are modified and the normally linear oxidation is transformed into a parabolic ΔG-time law. Only within the range of 1100 to 1200°C, the so-called range of catastrophic oxidation, is the oxidation again linear, but the rate is approximately one order of magnitude lower than with pure molybdenum in the same temperature range. The oxidation behavior of Mo + ZrO_2-cermets is characterized by the fact that below the MoO_3 melting point, the oxidation rate of the molybdenum is greatly increased, whereas above this melting point, it is markedly reduced. (auth)

38826 SYNTHESIS OF REFRACTORY COMPOUNDS OF THE TRANSITION METALS FROM THEIR SOLUTIONS IN MOLTEN METALS. Gurin, W. N.; Obuchov, A. P.; Korsukova, M. M.; Terent'eva, S. P.; Koslova, I. R. (Ioffe Inst. of Physics and Tech., Leningrad). Planseeber. Pulvermet.; 19: No. 2, 86-90 (Jun 1971). (In German).

Refractory borides, carbides, nitrides, and silicides of the metals of Group 4a—6a of the periodic system were produced in powder form by synthesis from solutions in molten zinc. The nitrides were prepared in quartz tubes. To prevent oxidation, an argon or nitrogen atmosphere was used and, simultaneously, nitrogen was passed through the melt. Preliminary studies of the binary systems transition metal-zinc and nonmetal-zinc revealed certain regularities concerning the reactions in these systems; new compounds of niobium and zinc were produced in powder form. The composition, crystal structure and chemical properties of these compounds were investigated. Through slow cooling of the zinc melt it is possible to obtain coarsely-crystalline powders of the transition metal silicides. The composition, crystal structure and some physicochemical properties of these powders were investigated. Similar syntheses are possible on other metal metals, e.g., cadmium, magnesium, and aluminum. (auth)

38827 MEASUREMENT AND THEORY OF HEAT HARDENING OF THE TRANSITION METALS, PARTICULARLY OF TANTALUM CARBIDE. Schwab, G.-M.; Krebs, A. (Univ., Munich. OSRAM GmbH, Munich). Planseeber. Pulvermet.; 19: No. 2, 91-110 (Jun 1971). (In German).

The Vickers hardness of tantalum carbide was measured within the entire homogeneity range of the monocarbide phase and of $NbC_{1.0}$ and α-$WC_{1.0}$ in the temperature range of 20 to 2330°C. Based on the experimental results, the temperature dependence of the hardness of these carbides is discussed in connection with dislocation theory and a relationship is established between the electronic structure and the hardness of the carbides, which in turn depend on the carbon stoichiometry, particularly for TaC_x. (auth)

38828 REACTION-ACCELERATING EFFECT OF THE ENERGY OF GRINDING PARTICLES OF URANIUM DICARBIDE ON ITS DECOMPOSITION. Schneider, F. H.; Nickel, H.; Naoumidis, A. (Kernforschungsanlage, Juelich, Ger.). Planseeber. Pulvermet.; 19: No. 3, 141-51(Sep 1971). (In German).

The thermal stability of UC_2 is very important for the application of coated particles with carbide kernels in H.T.G.R.'s (High-Temperature-Gas-Cooled-Reactors). There have been contradictory discussions in the literature concerning the decomposition of UC_2 to $U_2C_3 + C$. Reaction kinetics are shown to be strongly dependent on the supply of mechanical energy through grinding of UC_2. The beginning of decomposition of granulated UC_2 of various grain sizes was determined at various temperatures. The difference in activation energy of the reaction as determined for granulates of different grain sizes is of the same magnitude as the difference in mechanical energy used for granulation. (auth)

38829 OXYGEN DETERMINATION IN CEMENTED CARBIDES BY VACUUM DEGASSING. Lassner, E.; Schedle, H. (Metallwerk Plansee, Reutte/Tyrol, Austria). Planseeber. Pulvermet.; 19: No. 3, 152-8(Sep 1971). (In German).

Determination of oxygen in compact cemented carbides on WC−Co, WC−TiC−Ta(Nb)C−Co and $TiC-Mo_2C-Ni$ by the vacuum fusion method is described. The use of an auxiliary metal such as nickel-iron, cobalt, or nickel is essential. Addition of tin promotes the wetting of the cemented carbide specimens by the bath metal and, at the same time, prevents wetting of the graphite crucible. In contrast to the oxygen determination in the refractory metals, temperatures of approximately 2400°C are required, because at 1800°C the dissolution, particularly of the carbides, would take too long. Statistical indices are given for the method and the correctness of the analysis results proved by reference to the neutron activation method. (auth)

38830 SECONDARY PROCESSES IN THE EVOLUTION OF SPUTTER-TOPOGRAPHIES. Bayly, A. R. (Univ. of Sussex, Brighton, Eng.). J. Mater. Sci.; 7: No. 4, 404-12(Apr 1972).

Topographies of silica glass surfaces developed by 20 keV Ar^+ irradiation contain features which are not adequately explained by considering only the variation of sputtering yield with the ion-incidence angle. These features are sharply defined and could lead to serious misinterpretation of specimen structures when sputter-erosion is used as a microscopic sectioning technique. Three mechanisms are discussed which together could account for the observed discrepancies, the first being ion-reflection at grazing incidence, the second the phenomenon of forward-peaked emission of high-energy secondary particles under irradiation at high angles of incidence and the third being re-deposition of sputtered material onto closely adjacent planes. A general expression is derived for this latter mechanism for a cosine spatial distribution of sputtered particles. (auth)

38831 $(W_{0.2}V_{0.8})_3O_7$: PREPARATION AND CRYSTAL STRUCTURE. Darriet, Jacques; Galy, Jean (Univ., Bordeaux). J. Solid State Chem.; 4: No. 3, 357-61(May 1972). (In French).

The $(W_{0.2}V_{0.8})_3O_7$ synthesized at 650°C by solid state reaction crystallizes in the tetragonal system (space group is I4/mmm). The unit-cell dimensions are: a = 14.01 Å and c = 3.720 Å. The structure contains ReO_3-type blocks of metal oxygen octahedra 3 × 3 and infinite in extension along c. These blocks, joined up in the same plane by edge sharing, are packed together by additional edge sharing. Structural relations with $TiNb_2O_7$ are described. The structural formula as represented by Anderson's symbolism is given. (auth)

38832 SEGREGATION OF IMPURITY ATOMS IN NIOBIUM OXIDE. Anderson, J. S.; Browne, J. M.; Hutchison, J. L. (Oxford Univ.). Nature (London); 237: No. 5351, 151-3(19 May 1972).

Low-level impurities in niobium oxides are found to be segregated and allow a regular modification of the parent structure around them. Models for two such doped oxides are presented. (auth)

38833 ALLOYING OF LANTHANUM HEXABORIDE WITH HAFNIUM. Bondarenko, V. P.; Chernyak, L. V.; Shlyuko, V. Ya. Vestn. Kiev. Politekh. Inst., Ser. Mashinostr.; No. 8, 178-80(1971). (In Russian).

The coreduction of La_2O_3 and HfO_2 by boron in vacuum was studied. An alloy was obtained containing a solid solution of Hf in LaB_6 and HfB_2 and possessing elevated thermostability as compared with pure LaB_6. (JPRS)

38834 PHYSICOCHEMICAL INVESTIGATION OF THE $La_2O_3-GeO_2$ SYSTEM. Petrova, M. A.; Bondar, I. A.; Domanskii, A. I. (Inst. of Silicate Chemistry, Leningrad). Zh. Neorg. Khim.; 17: No. 3, 837-42(Mar 1972). (In Russian).

A phase diagram is given for the binary system $La_2O_3-GeO_2$. The existence of four compounds was demonstrated: $2La_2O_3 \cdot GeO_2$, the oxyortho-, the diortho-, and the germanate possessing an apatite structure. The physicochemical and crystalloptical properties of these compounds were studied, and the region of separation in the liquid state was established. (tr-auth)

38835 STUDY OF ALUMINUM–NICKEL–MOLYBDENUM OXIDE CATALYSTS BY ELECTRON PARAMAGNETIC RESONANCE. Samigov, K. A.; Talipov, G. Sh.; Inoyatov, N. Sh. Uzb. Khim. Zh.; No. 4, 37-9(1971). (In Russian).

The binary systems $Al_2O_3-MoO_3$ and $NiO-MoO_3$ were studied by EPR after heating to 350 and 600°C. The possibility of molybdate formation is discussed, and a structure is postulated which may explain the transition $Mo^{5+} \rightarrow Mo^{6+}$ at 600°C. (K.S.W.)

38836 STUDY OF THE URANIUM MONOCARBIDE–TUNGSTEN SYSTEM. Politis, C. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 39: No. 3, 258-64(Jun 1971). (In German).

The uranium monocarbide−tungsten system has been studied using metallographic and x-ray methods as well as microprobe and electron microscope analyses. The peritectic reaction has been confirmed and the peritectic temperature was found to be 2170° ± 10°C. Close to the peritectic line the solubility of tungsten in uranium monocarbide is of about 5 wt% W. The observed UWC_{2-x} phase has a monoclinic structure isomorphous with $UMoC_{1.7}$ phase and has the following lattice parameters: a = 5.624 ± 0.002 Å, b = 3.240 ± 0.001 Å, c = 11.640 ± 0.003 Å and $\beta = 109.6 \pm 0.1°$. The solubility curve of W in UC is given. UC with a small percentage tungsten seems to be chemically more stable than pure UC. (auth)

38837 ISOTHERMAL GRAIN GROWTH AND SINTERING IN PURE ThO_2 AND ThO_2-CaO COMPOSITIONS. Laha, S. N.; Das, A. R. (Indian Inst. of Tech., Kanpur). J. Nucl. Mater.; 39: No. 3, 285-91(Jun 1971).

Isothermal sintering and grain growth was studied in ThO_2-CaO compositions with 0, 2.31, 4.25, and 8.8 mole% CaO at temperatures of 1300, 1400, 1500, 1550, and 1600°C for 5, 10, 20, 30, 60, and 120 min and the data were correlated against Coble's model of intermediate stage sintering kinetics. Diffusion coefficients for the respective compositions were calculated as $1.3 \times 10^{-1} \exp(-93{,}000/RT)$, $4.02 \times 10^{-6} \exp(-56{,}000/RT)$, $4.35 \times 10^{-7} \exp(-47{,}000/RT)$ and $3.43 \times 10^{-7} \exp(-45{,}000/RT)$ cm^2/sec. The decrease in the activation energy with increasing percentage of CaO is qualitatively explained in terms of the effect of anion vacancy concentration on cation migration. (auth)

38838 HIGH TEMPERATURE THERMODYNAMIC DATA FOR UO_{2-x}. Wheeler, V. J. (Atomic Energy Research Establishment Harwell, Eng.). J. Nucl. Mater.; 39: No. 3, 315-18(Jun 1971).

Equilibrium oxygen potentials for UO_{2-x} in the temperature range 1800 to 2000°K have been measured, using a technique in which the UO_{2-x} sample was equilibrated in an oxygen potential controlled by the equilibrium: $2\,C + O_2 \rightleftharpoons 2\,CO$. The results agreed well with those obtained at higher temperatures using similar techniques employing the equilibrium: $2\,H_2 + O_2 \rightleftharpoons 2\,H_2O$. The formation of UC_2 from the reaction: $UO_2 + 4\,C = UC_2 + 2\,CO$ was found to occur at points on the UO_2/UC_2 phase boundary in good agreement with previous data. (auth)

38839 PLASTICITY OF CERMETS ON THE BASIS WC–Co. Arndt, Renate (Krupp Forschungsinstitut, Essen). Z. Metallk.; 63: No. 5, 274-80(May 1972). (In German).

The processes during plastic deformation of WC−Co cermets were investigated by replica and transmission electron microscopy of compressed specimens containing 9 and 25% Co, respectively. In WC slip processes were observed which were comparable to those of metals. Moreover, "WC grain boundary sliding" was observed. The Co phase was found to undergo a deformation induced transformation of individual cubic crystallites into numerous hexagonal crystallites. These results corroborate a model which attributes the onset of deformation to the deformation of the WC skeleton. The theories of dispersion hardening which are frequently applied to WC−Co cermets in the literature were not compatible with the results. (auth)

38840 HIGH-PRESSURE PHASE IN ARSENIC AND ITS RELATION TO PRESSURE-INDUCED PHASE CHANGES IN GROUP 5B ELEMENTS. Duggin, M. J. (CSIRO, Sydney). J. Phys. Chem. Solids; 33: No. 6, 1267-71(Jun 1972).

A high-pressure tetragonal polymorph of arsenic is reported for which a = 8.691 Å, c = 6.363 Å and c/a = 0.732. Previously published diffraction data for the high-pressure superconducting phases BiIII and SbIII are also indexed on the basis of tetragonal unit cells, with c/a ratios close to that of the high-pressure arsenic phase. Existing information is summarized on pressure-induced polymorphic transformations in the group 5B elements and similarities are pointed out between phase transformations occurring in the group. (auth)

38841 PROPERTIES OF GLASS IN THE SYSTEMS $MgO-TeO_2-V_2O_5$ AND $ZnO-TeO_2-V_2O_5$. Dimitriev, Y. B.; Marinov, M. R.; Ivanova, Y. Y. (Higher Inst. of Chemical Tech., Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 7, 897-900(1971).

Studies were made on the electric conductivity, density, crystallization capacity, softening temperature, and chemical stability of glass in the systems $MgO-TeO_2-V_2O_5$ and $ZnO-TeO_2-V_2O_5$. A comparison between the two systems indicated that for compositions with similar molar content the conductance in the zinc glasses was lower than that of the glasses with MgO. The activation energy ΔE (calculated from the temperature curves) varied within 0.40 and 1.0 eV, showing a considerable decrease with an increase in V_2O_5. The density of the glasses covered a broad interval (4.8 to 3.2 g/cm^3) and increased with increase in TeO_2 content. The softening temperature was generally low, and there was a tendency to decrease with increase in V_2O_5 content. (P.C.H.)

38842 EFFECT OF FISSION-FRAGMENT IRRADIATION UPON THE OXIDATION OF SILICON CARBIDE BY OXYGEN AT 950°C. Bennett, M. J.; Chaffey, G. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 39: No. 3, 253-7(Jun 1971).

The effects of fission-fragment irradiation on the oxidation of a silicon-bonded silicon carbide by oxygen have been studied at 950°C. The fission fragment flux was 1.4×10^9 ff/cm^2 sec and the exposure period varied up to 1400 h. The amount of oxidation was increased slightly by the irradiation. The enhancement increased with exposure, such that after 1400 h the oxidation of the irradiated specimens was greater than on the unirradiated controls by a factor between 1.3 to 1.7. The radioinduced oxidation probably resulted from a modification of the oxide film that facilitated ion-transport, although gas-phase radiolysis might also be responsible. (auth)

38843 EXPANSION OF SILICON CARBIDE BY NEUTRON IRRADIATION AT HIGH TEMPERATURE. Blackstone, R. (Reactor Centrum Nederland, Petten); Voice, E. H. J. Nucl. Mater.; 39: No. 3, 319-22(Jun 1971).

Published data for the neutron-induced expansion of silicon carbide appear to show that a damage/annealing equilibrium is reached at 4 or 5×10^{20} n/cm^2 DNE, with a thermal annealing effect superimposed to give saturation linear expansions ranging from about 1% at room temperature down to less than 0.05% at 1000°C. The present work suggests that this is not entirely true and that above 600°C another mechanism begins to cause continuous expansion, the rate increasing with temperature up to at least 1200°C, with doses up to 5×10^{21} n/cm^2. (auth)

38844 URANIUM–SILICON EQUILIBRIUM DIAGRAM. Vaugoyeau, H.; Lombard, L.; Morlevat, J. P. (CEN, Grenoble, France). J. Nucl. Mater.; 39: No. 3, 323-9(Jun 1971). (In French).

The uranium–silicon equilibrium diagram was mapped more precisely in the range 50 to 70 at.% silicon. The homogeneity ranges for the USi, U_3Si_5 and $USi_{1.88}$ phases were determined, and the peritectic origin of the first and last of these phases demonstrated. The hexagonal U_3Si_5 phase melts congruently. A new, tetragonal, crystal structure has been established for USi. (auth)

38845 HIGH-TEMPERATURE THERMAL LATTICE EXPANSION OF MIXED CARBO-NITRIDE AND URANIUM CARBONITRIDE. Ihara, Seiichi; Suzuki, Motokazu; Akimoto, Yumi (Mitsubishi Metal Mining Co. Ltd., Omiya, Japan). J. Nucl. Mater.; 39: No. 3, 311-14(Jun 1971).

Thermal expansion coefficients of uranium–20 at.% cerium carbonitrides were measured between the temperature range from room temperature to about 1600°C or above. The variation of lattice parameters was measured by means of a high-temperature x-ray diffractometer. In every case, the observed mean expansion coefficients remained constant between room temperature and about 1500°C. The calculated mean expansion was 9.95×10^{-6}, 9.55×10^{-6}, and 8.92×10^{-6}°C, respectively, for C/N = 0.67, 0.55, and 0.50. The coefficients of uranium carbonitride and uranium nitride also had a constant value of 9.17×10^{-6} and 6.91×10^{-6}°C, respectively, over a wide temperature range. (auth)

38846 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF REFRACTORY MATERIAL. (to SNAM Progetti SpA). British Patent 1,274,112. 10 May 1972. Priority date 8 Jan 1969, Italy.

A process for producing the porous refractory oxides of U, Th, Pu, Be, Si, Al, and Mg alone or in mixtures comprises heating the refractory material in finely divided form at a rate of from 320 to 480°C/hr to a maximum temperature in the range of 1280 to 1920°C, maintaining the heated material in this range for from 2 to 3 hr, and then cooling the refractory material at a rate of from 320 to 480°C/hr to a temperature in the range of 960 to 1440°C and then to room temperature at any desired rate. The atmosphere for heating the refractory material over the initial part of the heating stage should be inert or oxidizing, should be made reducing over the latter part of the heating stage at a temperature of at least 700°C but below the maximum temperature, and maintained reducing for the remainder of the process. (B.L.M.)

38847 PROCESS FOR THE PREPARATION OF SPHERICAL PARTICLES OF NUCLEAR FUEL. (to EURATOM). British Patent 1,273,948. 10 May 1972. Priority date 10 Apr 1970, Netherlands.

A sol-gel process for preparation of spherical particles of nuclear fuel consisting of mixed oxides and/or carbides and/or nitrides of U and Pu comprises mixing a concentrated denitrated solution of uranyl nitrate with a Pu hydroxide solution and an ammonia donor and gelling droplets of the mixture to form the spherical particles. Finely divided C must also be present when carbides and nitrides are required in the spherical particles. The nitrides can be formed by heating particles obtained from a C-containing mixture in a N_2 atmosphere. (B.L.M.)

38848 STUDIES ON THE SINTERING BETWEEN PbO AND PZT. 8. MECHANOCHEMISTRY OF THE SINTERED BODY. Yamaguchi, Osamu; Yasumoto, Masanori; Takeoka, Kiyoshi; Shimizu, Kiyoshi (Doshisha Univ., Kyoto). Funtai Oyobi Funmatsuyakin; 18: No. 5, 181-6(Jan 1972). (In Japanese).

A study was conducted to obtain fundamental information on nonstoichiometric PZT powders subjected to wet pulverizing. The effects of wet pulverizing and ball-milling (for 150 h.) on the structural properties of the powders were studied by thermobalance, x-ray diffraction, and by other methods. It was found that the weight of the specimens pulverized for a long time decreased continuously up to 900°C, due to the discharge of the bonding water caused by the mechano-chemical reaction between PZT and water during the pulverizing process. The crystallite dimension of the powder decreased for 25 ~ 50 hours. The lattice distortion, however, increased gradually with decreasing the crystallite dimension. This dimension was not restored to the original stage by heating to 900°C for the specimen pulverized for 150 hours. The layer of the bonding water penetrated gradually to the inner part of grains from the surface with increasing of the pulverizing time. The unfavorable effects on the properties of PZT appeared to be related to a long pulverizing time. Results of calculating the number of OH radicals, by assuming that the weight loss at 150 ~ 900°C is due to the bonding water, showed that the number of OH radicals increased with increasing of the pulverizing time; it attained nearly constant values after 100 hours. Judging from the results, the bonding water seemed to be not only that adsorbed on the surface of PZT particles but also that which penetrated into PZT grains, and formed the hydrogen bonding with the oxygen ion. After the long pulverizing time, the aggregation or agglomeration of the primary particles occurred and resulted in the growth of the secondary particles. (auth) (Japan)

38849 ZIRCONIUM–YTTRIUM–HYDROGEN SYSTEM. Shcherbak, V. I.; Bykov, V. N.; D'yakonov, B. P.; Kolesnikova, S. F. Zh. Neorg. Khim.; 17: No. 4, 1156-9(Apr 1972). (In Russian).

Ternary diagrams were constructed for the Zr–Y–H system at 25 and 700°C. X-ray analyses showed the formation of mechanical mixtures of compositions from the binary systems Zr–H and Y–H. (tr-auth)

38850 PHASE DIAGRAM OF THE METASTABLE $UC-UC_2$ SYSTEM. Laugier, J.; Blum, P. L. (CEN, Grenoble, France). J. Nucl. Mater.; 39: No. 3, 245-52(Jun 1971). (In French).

High-temperature x-ray diffraction studies were carried out on the $UC-UC_2$ system. The differences between formerly published results were found to be due to the existence of two distinct phase diagrams, a stable and a metastable one. The stable equilibrium diagram determined by Benz was found to be essentially correct except that carbon starts dissolving in UC at a temperature as low as 1100°C and that the UC_2 decomposition into U_2C_3 and carbon takes place at about 1100°C. The metastable diagram can be deduced from the stable one by suppressing the U_2C_3 phase, which induces a two-phase (UC + tetragonal UC_2) region of metastability up to 1840 ± 30°C. The UC_2 compositions are in close connection with the decrease of the lattice parameter c the values of which are corrected for the thermal motion effect. In the single-phase region the C/U concentration ratio ranged from 1.94 at 750°C to 1.65 on the left side and to 1.905 on the right side at 1840°C. This change in concentration explains the occurrence of a UC precipitate in the uranium-carbon alloys which contain free carbon. The metastability was found to be caused by a drastic reduction of the extensive diffusion of carbon. (auth)

38851 QUASI-ELASTIC THERMAL NEUTRON SCATTERING BY HYDROGEN IN α-VANADIUM HYDRIDE. de Graaf, L. A. (Inst. for Materials Research, Washington, D. C.); Rush, J. J.; Flotow, H. E.; Rowe, J. M. J. Chem. Phys.; 56: No. 9, 4574-81(1 May 1972).

The diffusion process of hydrogen in vanadium was studied by quasi-elastic thermal neutron scattering. Neutron linewidths associated with diffusion broadening were determined at 485°K for VH$_{0.198}$ and VH$_{0.570}$. These measurements cover a range of momentum transfers (Q) for elastic scattering up to 4.1 Å^{-1}. This is much larger than the momentum transfers obtained in earlier cold-neutron experiments, where no conclusive comparison was possible between data and proposed models involving diffusive jumps between octahedral and tetrahedral sites. The linewidth results for α-VH$_{0.57}$ are compared with these models and with an extension developed in the present paper. Although no complete agreement was obtained, this comparison leads to the conclusion that jumps between tetrahedral sites are predominant in the diffusion process. Differences in the linewidth behavior for VH$_{0.198}$ and VH$_{0.570}$ and the fact that the measured widths at large Q increase rapidly with Q rather than approaching an asymptotic value as predicted by the theory are discussed. It is suggested that these effects and the large Debye–Waller factors found in the present and previous neutron experiments are connected with the relative magnitudes of diffusion relaxation time and the jump time between sites. (auth)

38852 STUDY ON PHOSPHORUS DIFFUSION INTO SINGLE CRYSTAL SILICON BY THE LABELLED ATOMS TECHNIQUE. Kotas, P.; Pospisil, K. (TESLA, Prague). Radioisotopy; 13: No. 1, 225-36(1972). (In Czech).

The phosphorus diffusion into p-silicon in a flow system from $POCl_3$ and PCl_3 sources containing the labeled radionuclide ^{32}P was investigated in the temperature range from 1000 to 1150°C. After completion of the diffusion, the silicon layers were gradually removed by chemical etching or anodic oxidation. After addition of a carrier, magnesium pyrophosphate $Mg_2P_2O_7$ was precipitated from the individual etched off fractions. The beta radiation of the radionuclide ^{32}P in individual samples was then measured on a low-background counter. The results were then processed as diffusion profiles of the phosphorus concentration dependence on diffusion depth. The method of labeled atoms is compared with the electric resistance method and its advantages and drawbacks are discussed. (auth)

38853 MECHANISM FOR THE RADIATION COMPACTION OF VITREOUS SILICA. Primak, William (Argonne National Lab., Ill.). J. Appl. Phys.; 43: No. 6, 2745-54(Jun 1972).

The thermal spike hypothesis for the radiation compaction of vitreous silica by energetic ions is developed in detail. The variation of the thermal constants with temperature and the variation of energy dissipation along the range are considered and are found to affect the problem little. When the hypothesis was first presented, the thermal constants had not been determined, nor was the behavior of vitreous silica toward light ions known. The duration of thermal spikes calculated from current data is too short to account for the compaction by their thermal behavior alone. Therefore, the atomic nature of the processes is considered, and it is concluded that the process of compaction is facilitated and largely controlled by bond cleavage. However, the thermal excitation is essential in developing the configuration characteristic of the compacted state. (auth)

38854 HIGH-VACUUM CODEPOSITION OF NIOBIUM NITRIDE. Sterling, S. A. (Gulf General Atomic Co., San Diego, Calif.). J. Appl. Phys.; 43: No. 6, 2869-72(Jun 1972).

A technique was developed for the reactive high-vacuum codeposition of niobium nitride at rates in excess of several hundred Å/sec. With gaseous ammonia as the nitrogen source, films with transition temperatures in excess of 13°K were fabricated. The depression of the transition temperature from values reported for sputtered films is attributed to ammonia decomposition chemistry In addition, 4.2°K critical currents in excess of 10^6 A/cm^2 have been measured for 1-μ-thick films. (auth)

38855 RADIATION HARDENING OF THERMAL OXIDES ON SILICON BY DISPLACEMENT DAMAGE. Donovan, R. P.; Simons, M. (Research Triangle Inst., Durham, N. C.). J. Appl. Phys.; 43: No. 6, 2897-9(Jun 1972).

High-energy implantation of various ions into thermal oxides on silicon renders these oxides less sensitive to charge buildup when subsequently exposed to ionizing radiation. The reduced sensitivity is primarily a reduction in bias dependence and is attributed to ion-induced displacement damage in the oxide. (auth)

38856 REEXAMINATION OF EXPERIMENTAL STRENGTH-VS-GRAIN-SIZE DATA FOR CERAMICS. Carniglia, S. C. (Kaiser Aluminum and Chemical Corp., Pleasanton, Calif.). J. Amer. Ceram. Soc.; 55: No. 5, 243-9(May 1972).

The Orowan, Petch, and Knudsen equations were examined against 46 sets of strength-vs-grain-size data. For the 30 sets which are most discriminating, represented by 229 averaged-data points, the variances of the Orowan-Petch and Knudsen treatments are ≈4.5 and ≈17.1 kpsi^2, respectively. Statistical considerations give preference to the Orowan-Petch treatment at a high confidence level in these 30 cases, showing that the Knudsen equation does not remove systematic variations of strength as a function of grain size. The Orowan-Petch treatment also appears to provide a sounder basis for extrapolation. The identification of the Orowan and Petch equations with postulated physical models permits interpretation of data in terms of probable underlying causes. Several examples are discussed and in most cases agree at least qualitatively with present understanding. A satisfactory physical model for Petch behavior in nonyielding ceramics is needed. (auth)

38857 BINDING BETWEEN INERT-GAS BUBBLES AND RIGID PRECIPITATE PARTICLES. Markworth, A. J.; Baroody, E. M. (Battelle Memorial Inst., Columbus, Ohio). J. Nucl. Mater.; 39: No. 3, 348-9(Jun 1971).

It is demonstrated that one of the results in a previous study (Nelson, J. Nucl. Mater. 19: 149(1966)) on the binding energies associated with a number of bubble-precipitate configurations in which it was found that the net change of interfacial and surface energy, upon attachment of a bubble to a rigid, spherical, precipitate particle is zero is erroneous. It is shown, in fact, that as a result the binding between bubbles and precipitate particles can be significantly greater than was previously predicted. (P.C.H.)

38858 MODIFICATION OF THE Nb–C PHASE DIAGRAM. Brizes, W. F.; Brody, H. D. (Univ. of Pittsburgh). J. Amer. Ceram. Soc.; 55: No. 5, 277-8(May 1972).

Studies were made to determine experimentally the temperature at which Nb_2C becomes unstable in the Nb–C phase diagram. Photomicrographs of specimens quenched from 2600°C indicated that NbC was in equilibrium with liquid Nb at this temperature. From the microstructure of the precipitate, it appeared that Nb_2C formed peritecticly from liquid + NbC at a lower temperature. The microstructure of specimens quenched from temperatures between 2500°C and 2335°C indicated that Nb_2C was in equilibrium with liquid Nb, as expected. A proposed phase diagram is given. (P.C.H.)

38859 POSSIBLE CORRELATION BETWEEN DENSITY AND GRAIN SIZE DURING SINTERING. Gupta, T. K. (Westinghouse Research Labs., Pittsburgh). J. Amer. Ceram. Soc.; 55: No. 5, 276-7(May 1972).

Since simultaneous measurements of density and grain size during the later stages of sintering are relatively few, the relation between density and grain size has seldom been computed. Literature data for Cu, Al_2O_3, BeO, and ZnO were examined; it was found that, within the limits of experimental error, density and grain size are linearly related during the intermediate stage of sintering. (P.C.H.)

38860 PHASE BEHAVIOR IN THE Pu–Cr–N SYSTEM. De Luca, J. P.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc.; 55: No. 5, 273-4(May 1972).

A portion of the Pu–Cr–N phase diagram was studied as part of a broad, long-range plan to study the chemical interactions of nitride fuels with stainless steel in a breeder reactor environment. Powder compacts of various Pu/Cr ratios were mechanically blended and pressed at 80,000 psi into pellets. The solid starting materials (all −325 mesh) varied from pellet to pellet but in all cases were combinations of two of the following: PuN, PuH_3, Cr, Cr_2N, and CrN. The phases resulting after heat treatment showed that PuN does not react appreciably with Cr, Cr_2N, or CrN. Thus, two-phase equilibrium fields existed between PuN and Cr, Cr_2N, and CrN. The partial ternary phase diagram at 1 atm total pressure is given. (P.C.H.)

38861 SOME PROPERTIES OF PYROLITIC BORON NITRIDE. Novikova, N. A.; Vlasov, E. G.; Nepomnyashchii, L. B. Refractories (USSR) (Engl. Transl.); 12: No. 9-10, 677-80(Sep-Oct 1971). Translated from Ogneupory; 12: No. 10, 54-8(Oct 1971).

Pyrolitic boron nitride is a pore-free, vacuum tight material possessing low dielectric permeability, moderate dielectric loss, and a very low (the lowest of all known materials) coefficient of secondary electron emission. Owing to this, pyrolitic boron nitride is a promising material for use in electronics technology. The high thermal conductivity, and especially the structure, determine the excellent resistance to thermal shock of the articles made from pyrolitic boron nitride. The relatively high density, excellent resistance to oxidation, chemical inertness to most reagents, structural features, and especially the strength at elevated temperatures opens up wide possibilities for employing pyrolitic boron nitride in chemical and metallurgical industries, in semiconductor techniques, and other regions of technology. (auth)

38862 EFFECT OF ADDITIONS OF MONOCLINIC ZIRCONIA ON THE SPALLING RESISTANCE AND PHASE COMPOSITION OF ZrO_2–Y_2O_3 SOLID SOLUTION SPECIMENS. Kuznetsov, A. K.; Krasil'nikov, M. D.; Tikhonov, P. A. (Inst. of Silicate Chemistry, Moscow). Refractories (USSR) (Engl. Transl.); 12: No. 9-10, 608-11(Sep-Oct 1971).

Translated from Ogneupory; 12: No. 9, 52-6(Sep 1971).

Monoclinic ZrO_2 incorporated into zirconia–yttria solid solutions of the composition 7% (mole) Y_2O_3 + 93% (mole) ZrO_2, changed during heating into a solid solution of the monoclinic modification, as indicated by the reduction in the temperature of the polymorphic inversion of the monoclinic phase. The formation of the monoclinic solid solution began at about 1200°C, and took place as a result of the partial solution in the incorporated ZrO_2 of zirconia–yttria solid solution of the cubic modification. With an increase in the firing temperature to 2200°C there was a redistribution of the Y_2O_3 in the specimen, as a result of which the resulting monoclinic solid solution changes into a solid solution of the cubic modification. The maximum quantity of monoclinic ZrO_2 which can be assimilated by the solid solution of the composition 7% (mole) Y_2O_3 + 93% (mole) ZrO_2 with the preservation of the cubic structure in the material at 2200°C and a soak of 3 h was 50% by weight. An addition of monoclinic ZrO_2 positively affected the thermal-shock resistance of the specimens of zirconia–yttria solid solution only as long as it was not changed, as a result of the redistribution of the Y_2O_3, into a solid solution of the cubic modification. (auth)

38863 DETERMINING THE SURFACE AREA OF REFRACTORIES. Strelov, K. K.; Ishigilov, G. P. Refractories (USSR) (Engl. Transl.); 12: No. 9-10, 663-5(Sep-Oct 1971).

Translated from Ogneupory; 12: No. 10, 41-4(Oct 1971).

To determine the complete specific surface area of refractory products and powders, both methods of the BET specification, that is, with respect to nitrogen and carbon dioxide adsorption, are recommended. The use of carbon dioxide gas instead of liquid nitrogen has certain advantages connected with the acquisition, transporting, and storage of the material. Determination of the surface area by the mercury porosimeter method gave values close in orders of magnitude to the values obtained by the BET method, but could not replace the latter. The permeable external surface area of products can be approximately evaluated with respect to the gas permeability and porosity, and also on the PSKh-4 instrument. (auth)

38864 STRUCTURAL AND PHASE CHANGES DURING SERVICE OF RESISTANCE HEATERS BASED ON ZIRCONIA. Rutman, D. S.; Taksis, G. A.; Perepelitsyn, V. A.; (and others). Refractories (USSR) (Engl. Transl.); 12: No. 9-10, 666-71(Sep-Oct 1971).

Translated from Ogneupory; 12: No. 10, 44-9(Oct 1971).

During service, resistance heating elements undergo structural transitions which are expressed mainly by the radial directed selective recrystallization and changes in the nature of the porosity. In heaters made from zirconium dioxide stabilized with calcium oxide the predominant crystal growth is directed from the external surface to the center of the section, and when stabilization is done with cerium dioxide the direction of the crystal growth is diametrically opposite. With a reduction in the rate of recrystallization in identical conditions the heating elements can be arranged, as a function of the stabilizing additives, in the following series: CaO > CeO_2 > Y_2O_3. The change in the porosity is expressed by an increase in the dimensions and a reduction in the total volume of the pores. As regards the capacity for enlargement of the pores, the heating elements form the following series as a function of the stabilizing additive: CeO_2 > CaO > Y_2O_3. In the heating element containing calcium oxide the pores after prolonged service acquire a fan-shaped form and are orientated parallel to the longitudinal axis of the heating element, mainly close to its external surface: in the heater containing cerium oxide the large pores are stretched out towards its internal surface. The maximum resistance to structural and phase changes is possessed by heaters containing yttrium oxides. After service for 250 h at 2000°C the heaters undergo no phase changes. The fundamental structural changes in the heaters during high-temperature service do not give rise to appreciable changes in their electric conductivity. (auth)

38865 PHASE BEHAVIOR IN THE ThN–ThO_2–Th SYSTEM. Kusakabe, Takao; Imoto, Shosuke (Osaka Univ.). J. Jap. Inst. Metals; 36: No. 4, 305-9(Apr 1972). (In Japanese).

ThN powder, prepared by the reaction of metallic thorium with nitrogen and subsequently by the decomposition of the formed Th_3N_4, was intimately mixed with Th and ThO_2 in various ratios. These mixtures compacted in a disc form were heated at 1600°C for 17 h or 1800°C for 5 h in vacuum. Ceramographic, x-ray, and chemical analyses of the samples showed a limited oxygen dissolution in ThN under these conditions. The main results thus obtained are as follows: The composition of the resulting ThN phase with maximum solubility of oxygen was $ThN_{0.79}O_{0.19}$ at 1600°C and $ThN_{0.71}O_{0.30}$ at 1800°C. The ThN phase seemed to dissolve oxygen along the line from ThN to hypothetical (ThO). The lattice parameters of $ThN_{0.79}O_{0.19}$ and $ThN_{0.71}O_{0.30}$ respectively decreased to 5.157 ± 0.001 Å and 5.155 ± 0.001 Å from that of original ThN (5.158 ~ 5.159 Å). (auth)

38866 THERMODYNAMICS STUDIES ON SOME RARE-EARTH DICARBIDES. Anderson, J. S.; Bagshaw, A. N. (Oxford Univ.). Rev. Chim. Miner.; 9: No. 1, 115-38(1972).

Thermodynamic data for the dicarbides of lanthanum, cerium, praseodymium, neodymium, samarium, gadolinium, dysprosium, erbium, ytterbium, and yttrium were obtained from a study of the dicarbide/carbon two-phase region using a solid state galvanic cell with calcium fluoride electrolyte in the temperature range 900 to 1300 K. The results were compared with those obtained by other methods (mainly by mass spectroscopy). It was found that ΔG_f^0 agrees well with mass spectrometric measurements and that a third law evaluation leads to ΔH^0(298 K) values consistant with the best literature values for LaC_2, CeC_2, and YC_2. Data for PrC_2, NdC_2, GdC_2, DyC_2, and ErC_2 are advanced on this basis and show a systematic, increasingly negative trend with decrease of atomic radius. Second law reduction of data gave erroneous results. This anomaly is discussed in the light of the experimental techniques used, and the limitations of solid state fluoride galvanic cells for determining thermochemical data on refractory compounds are discussed. Additional experiments were performed on the sesquicarbides of the first four lanthanides and gadolinium and on a number of intermediate compositions in the yttrium–carbon system. Evidence is presented for a low symmetry form of the dicarbides of thulium and ytterbium, stable under ambient conditions. (France)

38867 DEFORMATION IN A CEMENTED CARBIDE TOOL BIT DURING THE TURNING OF STEEL. Jonsson, H. (Aktiebolaget Atomenergi, Fagersta, Sweden). Planseeber. Pulvermet.; 20: No. 1, 39-62(Mar 1972).

After turning of steel, a tool bit of WC–TiC–TaC–NbC–Co cemented carbide (ISO P 10) had large gradients of microhardness. These gradients may give information on the stress distribution in the bit during machining. In a region at the clearance face a considerable porosity arose which was detrimental to the strength of the tool. The rate of flank wear is proposed to be to a large extent dependent on the strength of the material. Plastic deformation which can lead to pore formation can be seen to occur both in the binder phase and the carbide grains. Around the crater a complex state of stress in the tool is indicated from studies on the formation of cracks from corners of Vickers impressions. The penetration depth of Fe from the machined metal into the cemented carbide may give information on the cutting temperatures. In this way a high temperature was implied both on the rake side—higher than the melting point of the binder phase in the remote part of the crater from the cutting edge—and on the clearance side, at least when the bit had begun to show considerable wear. (auth)

38868 FATIGUE OF A WC–25 PERCENT Co ALLOY. Davies, T. J.; Barhana, S. (Univ. of Manchester, Eng.). Planseeber. Pulvermet.; 20: No. 1, 30-8(Mar 1972).

Specimens of a WC-25% Co alloy with differing surface finish were tested in a rotating beam cantilever fatigue machine at stresses approximately 60% to 70% of the ultimate tensile strength of the alloy. The fatigue life was observed to increase with improved surface polish and varied linearly with applied stress. An increase in the planar fatigue area at the higher stresses is attributed to crack blunting. Although no fatigue striations were observed in the fracture surface a slow crack growth stage was detected. The fracture path was constrained to the cobalt binder phase almost exclusively. (auth)

38869 INFLUENCE OF CHROMIUM AND NICKEL ON THE STRUCTURE OF WC–Co CEMENTED CARBIDES. Petrdlik, M.; Kulcickyj, I. (Research Inst. for Powder Metallurgy, Sumperk, Czech.). Planseeber. Pulvermet.; 20: No. 1, 20-9(Mar 1972). (In German).

The influence of 0.3% nickel and chromium, respectively on the structure of WC-10 Co cemented carbides was investigated. The metals were added in form of water soluble salts to tungstic acid of different particle size. Whereas chromium always causes marked grain refinement in the carbide phase, nickel additions result in grain coarsening varying with particle size of the tungsten acid. The mechanism of action of these additions is discussed. (auth)

38870 THERMODYNAMIC STUDY OF HYPOSTOICHIOMETRIC URANIA. Javed, N. A. (Argonne National Lab., Ill.). J. Nucl. Mater.; 43: No. 3, 219-24(Jun 1972).

Transpiration experiments have been performed in the temperature range 1600 to 1900°C to study the thermodynamics of hypostoichiometric urania. The oxygen partial pressures were established by using flowing H_2/H_2O mixtures. After equilibration the quenched products were analyzed by chemical, x-ray, and metallographic techniques. The results are plotted as $\Delta\overline{G}o_2$ versus the O/U ratios for various temperatures. $\Delta\overline{H}o_2$ and $\Delta\overline{S}o_2$ have been calculated for O/U ratios of 1.99 to 1.98 in the temperature range 1600 to 1900°C. No significant changes in the lattice constants of the quenched products as a function of O/U ratios were observed. This, plus the present metallic inclusions observed by metallographic examination indicated that hypostoichiometric urania reverts to stoichiometric UO_2 and uranium metal during cooling to room temperature. (auth)

38871 THERMAL CONDUCTIVITY OF PLUTONIUM-URANIUM DIOXIDE AT TEMPERATURES UP TO 1273 K. Goldsmith, L. A.; Douglas, J. A. M. (United Kingdom Atomic Energy Authority, Seascale, Eng.). J. Nucl. Mater.; 43: No. 3, 225-33(Jun 1972).

The variation of the thermal conductivity of hypostoichiometric (plutonium–uranium) dioxide (oxygen-to-metal ratio 1.99) with plutonium contents between 16 and 30 wt%, has been studied over the temperature range 673 to 1273°K, using the laser-flash method. Within this range of composition, the thermal conductivity was found to be effectively independent of plutonium content. Heating in vacuo for several hours at 1273°K caused an increase in thermal conductivity which was found to be due to the oxygen-to-metal ratio of the specimens approaching closer to 2.00. At 673°K an increase in oxygen-to-metal ratio of 0.007 caused an 8% increase in thermal conductivity, but at 1273°K the same change in oxygen-to-metal ratio did not materially alter the conductivity. These results agreed well with those of others on similar materials. (auth)

38872 FORMATION OF UC–UN SOLID SOLUTIONS. Nomura, T. (Osaku Univ.); Katsura, M.; Sano, T.; Kai, H. J. Nucl. Mater.; 43: No. 3, 234-44(Jun 1972).

In order to elucidate the mechanisms of the formation of the solid solution between UC and UN, some experiments were carried out using several kinds of combination as the starting materials; UC, UC_2, UC + UN, and UN + graphite. The results showed that free carbon precipitating through the reaction of UC with nitrogen gas was not graphite but amorphous carbon with more or less incomplete graphitization. The degree of graphitization was a function of temperature. These amorphous carbons may have been a frequent cause of the scattering results obtained by many workers up to the present time. The mixture of UN and graphite was the best combination as the starting materials to investigate the equilibrium of the region consisting of UC–UN solid solution and free carbon, from both equilibrium and kinetic points of view. During the course of the reactions, UC + N_2 and UN + graphite, an intermediate state may appear, which includes two phases of UC–UN solid solutions, one having the composition corresponding nearly to the equilibrium one and the other being a solid solution with the composition different from the equilibrium one. The diffusion of non-metal atoms through the UC–UN solid solution-layer may control the overall reaction. (auth)

38873 ROOM AND ELEVATED TEMPERATURE PROPERTIES OF BALL-MILLED ALUMINUM–ALUMINUM OXIDE ALLOYS (A COMMENT ON A PAPER BY N. C. KOTHARI). Hansen, N. (Danish Atomic Energy Commission, Riso). J. Nucl. Mater.; 43: No. 3, 339-40(Jun 1972).

Comments are given on a previous article by Kothari, J. Nucl. Mater. 41: 303 (1971) on the properties of Al – Al_2O_3 products manufactured by consolidation of ball-milled Al powder. The objective of the previous article was to obtain products in which the Al_2O_3 particles are uniformly distributed in the Al matrix. The objective was based on the assumption that the SAP alloys are not free from agglomerations of the oxide phase. (P.C.H.)

38874 TECHNIQUE FOR MEASURING THE STRENGTH OF HIGH TEMPERATURE REACTOR FUEL PARTICLE COATINGS. Gilchrist, K. E.; Brocklehurst, J. E. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Nucl. Mater.; 43: No. 3, 347-50(Jun 1972).

A method for assessing the tensile strength of individual coatings (SiC) on reactor fuel particles using an internal pressure technique on hemispherical shells separated from the particles is described. The method establishes a stress system similar to that which the SiC shell must withstand during service as the build-up of internal pressure, caused by the generation of fission-product gases, offsets the compressive stress imposed by the radioinduced shrinkage of the pyrocarbon. (P.C.H.)

38875 THERMAL DIFFUSIVITY OF MIXED $(Th_{1-x}U_x)$ OXIDES AND SOME MATERIALS TO BE USED AS REFERENCE IN THE RANGE 650 TO 2700 K. Ferro, C.; Patimo, C.; Piconi, C. (CNEN, Rome). J. Nucl. Mater.; 43: No. 3, 273-6(Jun 1972).

Thermal diffusivities of (Th,U) oxides and various reference materials were measured between 650 and 2700°K. The measurements were made using the "flash" technique. All the data were fitted to a 1/T law and the mean free path of phonons was calculated directly from the thermal diffusivity. (auth)

38876 KINETICS OF PORE MOVEMENT IN UO_2 FUEL RODS. Sens, P. F. (Reactor Centrum Nederland, Petten). J. Nucl. Mater.; 43: No. 3, 293-307(Jun 1972).

The movement of pores in UO_2 fuel elements occurs by diffusion of UO_2 vapor molecules across the pores with the temperature and concentration gradients as driving forces. The corresponding diffusion equation was derived and solved numerically throughout the pore volume with the PROFORMA-2 computer program. The pore velocity was found to depend on the shape of the pore and the initial pore shape changed during migration. Disc shaped pores had the highest velocity and transform, in moving, to the commonly observed lenticular voids, pinching off small voids at its circumference. The net velocity of these pores as a function of temperature and temperature gradient is given and applied in the POREMOVSKY computer program to calculate the redistribution of porosity, power generation and temperature at different time intervals. Generally, good agreement was found between calculated and observed microstructural changes, the majority of which appeared to take place early in the irradiation period. (auth)

38877 REACTION FUEL (OXIDE MIXTURE $(UPu)O_{2\pm x}$) CLADDING INTERFACE (STAINLESS STEEL) IN IRRADIATED FUEL ELEMENTS. de Keroulas, F.; le Beuze, R.; Calais, D.; van Craeynest, A.; Conte, M. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater.; 43: No. 3, 313-20(Jun 1972). (In French).

During operation of a reactor, fission causes oxidation of the fuel $(U,Pu)O_{2-x}$. For a certain value of á, which is a function of the composition of the steel of the cladding, thermodynamic considerations imply oxidation of the cladding by the fuel. This reaction is limited by the very low mobility of chromium and oxygen in oxides of the ferrite type, $(Cr,Fe)_2O_3$, which form at the fuel/cladding interface. Nevertheless the reaction may proceed by the intermediary of volatile fission products, the more so where the internal stresses due to swelling of the fuel and to the thermal gradient may cause cracking of the protective oxide layer. Tellurium reacts with the steel to yield a phase rich in chromium and manganese (19 and 6 wt% respectively). A superficial reduction in chromium content results and this reduces the oxidation resistance of the steel. Iodine leads to vapor-phase transport. Cesium iodide (a compound of fission products) attacks the grain boundaries in the steel by depositing cesium while forming a mixture of iron iodide and chromium iodide vapors. These volatile iodides migrate towards hotter zones and decompose in regions at temperatures around 900°C. (auth)

38878 OXIDATION OF URANIUM CARBIDES IN SODIUM WITH A SMALL OXYGEN CONTENT. Watanabe, H.; Kikuchi, T.; Furukawa, K. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 43: No. 3, 321-9(Jun 1972).

Oxidation of uranium carbide in sodium containing oxygen (5 to 10 ppM) was studied by means of metallography, x-ray analysis and electron probe microanalysis for various exposure times between 25 and 1240 h at 700°C. UO_2 and UC_2 phases were found to be formed in the oxidized layer of uranium monocarbide. Furthermore, carbon transfer occurred from carbide to stainless steel through sodium during oxidation. The oxidation process of uranium monocarbide was concluded to proceed by the following two step reactions: Step (1): 2UC + 2O (in Na) = UO_2 + UC_2, and Step (2): UC_2 + 2O (in Na) = UO_2 + 2C (in Na). The rate of oxidation was estimated to be 6.5×10^{-5} mm/h for sintered carbides. (auth)

38879 KINETIC RE-SOLUTION OF FISSION GAS; ASYMPTOTIC BEHAVIOR. Markworth, A. J. (Battelle Memorial

Inst., Columbus, Ohio). J. Nucl. Mater.; 43: No. 3, 341-2(Jun 1972).

A simple heuristic model was developed to describe the effects of re-solution upon bubble-growth kinetics. Emphasis was placed upon asymptotic times, for which the mathematical analysis became particularly simple. On the basis of this model, it is predicted that the principal asymptotic effect of re-solution is to substract from the bubble radius, a time-independent term which is proportional to and inversely proportional to both n and D. In this case, b = the probability, per unit time, that a gas atom contained with a bubble be re-injected into the solid, n = a system of spherical bubbles per unit volume, and D = gas-diffusion coefficient. (P.C.H.)

38880 STAGE AND FUTURE PROSPECTS OF DEVELOPING FUEL ELEMENTS FOR LIGHT-WATER REACTORS IN THE COUNTRIES OF THE EUROPEAN COMMUNITY. Siebker, Manfred; Colling, Armand (Europaeische Gemeinschaft, Brussels). At. Strom; 18: No. 3-4, 59-63(Mar-Apr 1972). (In German).

The development potentialities of the present-day fuel element technology for light-water reactors are exhausted to a great extent. In order to satisfy the increasing demands of the engineering firms and producers of electrical energy, it seems important for this reason to develop the today's technology at medium-term and to consolidate its scientific basis as well as to push the development scheme with respect to an improvement of the raw materials and fuel element concepts in a long-range project. In member countries of the European Community, promotion of the developmental work from public funds seems to be called for also in the future. (auth)

38881 RELATION BETWEEN MACROSCOPIC THERMODYNAMIC QUANTITIES AND THE THERMODYNAMIC PARAMETERS OF DEFECTS FORMATION IN NON-STOICHIOMETRIC ZrO_2. Loup, J. P. (Faculte des Sciences, Dakar, Senegal); Anthony, A M. J. Phys. Chem Solids; 33: No. 6, 1273-8(Jun 1972).

The thermodynamic properties of nonstoichiometric zirconia were investigated on the basis of results of thermionic emission and conductivity experiments. These measurements established the pressure $(p_{O_2})_S$ corresponding to stoichiometric zirconia in the 1270 to 2000°K temperature range, by using a microscopic model of an oxide exhibiting a slight deviation from stoichiometry. The relationship between the microscopic model involving structural elements, and the macroscopic model relating to chemical elements, is specified. Calculations were made of the variations in chemical potential of zirconium $(\Delta\mu_{Zr})_S$ and monatomic oxygen $(\Delta\mu_O)_S$ during the formation of the stoichiometric oxide. It was deduced that the slope of the tangent to the curve of the free enthalpy mixing of a gram-atom $\Delta g_m(X_O)$ in the Zr–O system is positive for the stoichiometric composition. The dissymmetry of this curve, revealing the tendency of zirconia to exhibit an excess of metal rather than an excess of oxygen, is in agreement with a theory, by Kroger (J. Phys. Chem. Solids 29: 1889(1968)), concerning transition metal oxide in a state of maximum oxidation. The determination of the oxygen pressure at stoichiometry led to the derivation of various basic thermodynamic quantities pertaining to the nonstoichiometry of oxides. (auth)

38882 SPECIFIC HEAT OF THORIUM MONONITRIDE FROM 7^0 TO 300^0K. Danan, J.; de Novion, C.-H.; Dallaporta, H. (CEN, Fontenay-aux-Roses, France). Solid State Commun.; 10: No. 9, 775-8(1 May 1972).

The specific heat of ThN was measured between 7 and 300°K by an adiabatic method with continuous heating, and compared to that of UN. The magnetic specific heat of UN between 50 and 300°K was lower than that of a U^{4+} ions gas submitted to an octahedral crystal field of about 500 cm^{-1}. (auth)

38883 HIGH PURITY HOT PRESSED BORON NITRIDE. Mandorf, Victor Jr.; Montgomery, Lionel C. (to Union Carbide Corp.). U. S. Patent 3,660,027. 2 May 1972. Filed 6 May 1969.

Improved boron nitride articles having a unique acicular crystal structure, an oxygen content of less than 0.5 percent by weight, a density of at least 1.9 grams/cc, excellent hot strength, low and substantially isotropic coefficients of thermal expansion with no irreversible thermal expansion, excellent thermal shock resistance, moisture insensitivity, and improved dielectric properties are described. These articles are produced by treating conventional hot pressed boron nitride articles with a suitable solvent to lower their boron oxide (B_2O_3) content, and then sintering the treated material in an inert atmosphere at a temperature of from 1,600° to 2,100°C in the absence of pressure or mechanical restraint. (Official Gazette)

38884 POLYMORPHISM IN VACUUM CONDENSATES OF TANTALUM. Belevskii, V. P.; Belous, M. V.; Permyakov, V. G.; Yashnik, V. M. (Kiev Polytechnic Inst.). Fiz. Metal. Metalloved.; 32: No. 6, 1297-9(Dec 1971). (In Russian).

Tantalum films were prepared by cathodic sputtering in an Ar atmosphere with additions of N_2. Using x-ray-diffraction patterns, a conversion of the β phase into the α phase in vacuum at 700 to 750°C was observed. This process was accompanied by a reduction in the specific electrical resistance. (K.S.W.)

38885 CHEMICAL STABILITY OF MOLYBDENUM AND TUNGSTEN BORIDES. Kugai, L. N. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 12, 982-4(Dec 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 12, 54-7(Dec 1971).

It has been established that molybdenum and tungsten borides oxidize during storage in air and generally contain a significant amount of oxides. A method is proposed for ridding molybdenum and tungsten borides of oxides, involving treatment with 2% hydrochloric acid and 1% oxalic acid, respectively. A study was made of the chemical stability of molybdenum and tungsten borides in some acids, mixtures of acids with oxidizing and complexing agents, oxidizing mixtures, and alkaline solutions. (auth)

38886 EXTRUSION OF RODS AND TUBES OF VARIABLE CROSS SECTION. Kislyi, P. S.; Kindysheva, V. S.; Kuzenkov, V. N.; Yanushkevich, R. T. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 12, 1012-14(Dec 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 12, 92-5(Dec 1971).

Special extrusion die units that were developed for the extrusion and sintering of carbide tubes and rods of variable cross section for producing heating elements of this type which require no additional fabrication are described. In one die unit the principal shaping element is the internal mandrel of variable cross section, which can slide axially in the guides of the spider. In the other, a unit with a fixed mandrel, the chief forming elements are the split die, consisting of three parts, and the mandrel, which is screwed into the spider. (P.C.H.)

38887 SOLUBILITY OF CERTAIN RARE EARTH OXIDES IN FUSED CRYOLITE. Belov, S. F.; Gladneva, A. F.; Chubar, Yu. D.; Igumnov, M. S. (Moscow Inst. of Fine Chemical Tech.). Inorg. Mater. (USSR) (Engl. Transl.); 7: No. 11, 1781-3(Nov 1971).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 7: No. 11, 2001-3(Nov 1971).

The stability of cryolite in an inert atmosphere was studied along with the solubility of La_2O_3, CeO_2, Pr_6O_{11}, Nd_2O_3, and Sm_2O_3 in fused cryolite at different temperatures. It was established that the solubility of rare earth oxides in fused cryolite has a chemical character. (auth)

38888 MECHANISM OF STRUCTURAL TRANSFORMATIONS IN BORON NITRIDE. Fel'dgun, L. I.; Nikitina, T. P.; Sokhor, M. I.; Futergendler, S. I. (All-Union Inst. of Abrasives and Grinding, Leningrad). Russ. J. Phys. Chem. (Engl. Transl.); 45: No. 12, 1738-40(Dec 1971).

Translated from Zh. Fiz. Khim.; 45: No. 12, 3067-70(Dec 1971).

A microstructure and x-ray-diffraction study was made on the products of the synthesis of cubic boron nitride from pyrolytic hexagonal boron nitride using a solvent melt. Under the given experimental conditions there is virtually no direct transition from hexagonal to cubic boron nitride. The importance of the role of the solvent melt in the phase transformation of boron nitride is noted. (auth)

38889 THERMAL CONDUCTIVITY OF ZIRCONIUM CARBIDE AT HIGH TEMPERATURES (2100 TO 3400^0K). Fedorov, V. B.; Aleinikov, I. N. High Temp. (USSR) (Engl. Transl.); 9: No. 5, 984-5(Sep-Oct 1971).

Translated from Teplofiz. Vys. Temp.; 9: No. 5, 1076-7(Sep-Oct 1971).

Measurements of thermal conductivity in ZrC were made using a radial flux from an internal heat source. A photographic method of temperature measurement was used at two depths in the sample surface. Results of measurements are compared with previous experimental data. A nonlinear rise in thermal conductivity with approach to the melting point appears related to the increasing role of the phonon component. (J.R.D.)

38890 DEFECTS IN SILICON CARBIDE. Stevens, R. (University Coll. of Wales, Swansea). J. Mater. Sci.; 7: No. 5, 517-21(May 1972).

Defects in various forms of SiC, both single crystal and polycrystalline, were examined using transmission electron microscopy. Dislocations were not as common as stacking faults, which were observed in all materials examined. The mechanism of formation of stacking faults is discussed, and two types of both intrinsic and extrinsic faults were found possible. The stacking-fault energy of SiC was measured to be 1.9 ergs/cm^2 by the extended node method. (auth)

38891 CONCENTRATION DEPENDENCE OF LATTICE PERIODS OF MONOCARBIDES OF TRANSITION METALS OF GROUPS IV AND V. Tskhai, V. A.; Alyamovskii, S. I.; Gel'd, P. V.; Shveikin, G. P. Zh. Neorg. Khim.; 17: No. 3, 602-4 (Mar 1972). (In Russian).

The causes of a concentration dependence of lattice periods of cubic carbides of Ti, Zr, and Hf on the one hand, and of V, Nb, and Ta on the other are discussed. The effects of Me–C bond, and also shielded and unshielded Me–Me bonds, on the dimensions of the elementary cell of the given carbides were examined. Progressive implantation of carbon atoms into the octahedral intervals of the dense packing of metal atoms, and the significance of the Me–C distance in large or small lattice periods are considered. (tr-auth)

38892 METHOD OF MANUFACTURING A MATERIAL-METAL JUNCTION: ASSEMBLY OBTAINED USING THIS METHOD Marini, Jean; Roule, Maurice (to Commissariat a l'Energie Atomique). French Patent 2,079,836. 18 Oct 1971. Filed 13 Feb 1970. (In French).

A junction was formed between a material (ceramic or vitreous) and a metal, which can resist high temperatures. This junction enabled an ultrasound transducer, which can operate at high temperatures, in a corrosive medium (e.g., the liquid Na coolant of a nuclear reactor) to be developed. The complementary faces to be joined of the material and the metal are polished. A layer of colloidal Ag is deposited on these faces. The organic binder contained in the colloidal Ag is evaporated. The two fine Ag layers produced are then pressed together at high temperature in a neutral atmosphere. (France)

38893 GENERATION OF PRISMATIC LOOPS BY NITRIDE PRECIPITATES IN NIOBIUM. Dahlstrom, N.; Eyre, B. L. (Univ. of Illinois, Urbana). Metal Sci. J.; 6: 96-101(May 1972).

An electron-transmission microscope study was made of the structural changes that occur in quenched niobium–nitrogen alloys on aging at 535°C. Initially, nitride precipitate plates form on $\{100\}$ planes in the matrix and when they reach a critical size, apparently defined by both diameter and thickness, dislocation loops and segments are generated. The Burgers vectors of the dislocations are of the type $\frac{1}{2}\langle 111\rangle$ and the loops are interstitial in nature. It is considered that the dislocation structure is generated to accommodate the misfit strain associated with the nitride platelets. (auth)

38894 HIGH-TEMPERATURE CREEP OF ZIRCONIUM CARBIDE. Miloserdin, Yu. V.; Naboychenko, K. V.; Cheburkov, V. I.; (and others). Probl. Prochnosti; No. 3, 50-3(1972). (In Russian).

Results are presented from creep and long-term strength tests of specimens of zirconium carbide in the 2,450 to 2,810°K temperature range. The behavior of zirconium carbide in various stages of creep and the relationship between parameters characterizing creep and the test conditions of the material were studied. It was demonstrated that in the 2,450 to 2,810°K temperature interval with stresses of 0.3 to 1.0 kg/mm^2, the stable stage of creep of zirconium carbide is determined by a diffusion process with an activation energy of 116 ± 18 kcal/mol. (JPRS)

Metals and Alloys

Refer also to abstract 38126.

38895 MARKET FOR URANIUM AND PLUTONIUM. Mommsen, Jack (Nuclear Exchange Corp., Palo Alto, Calif.). Nucl. News; 15: No. 5, 39-41(May 1972).

It is noted that in the first half of the 1970-to-1980 period a uranium oversupply is being experienced in the market primarily because of delayed nuclear plant construction. However, in the last half of this period it is felt that an undersupply of uranium will be evident. It is also felt that plutonium recycle development should be accelerated during this period. A review of price trends for uranium and plutonium is included. (J.R.D.)

38896 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. April 1972. Band 2, Heft 4. 233 Referate (Register-Nr.929-1392), 61 Referate (Register-Nr.278T-338T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. April 1972. Vol. 6, No. 4. 233 Abstracts (Register No. 929-1392), 61 Abstracts (Register No. 278T-338T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1972). 127p. (In German and English).

38897 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Band 6, Heft 1-3. 1. Vierteljahresregister 1972. (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. Vol. 6, No. 1-3, 1972. 1st Quarter Index). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.B.H (1972). 62p. (In German and English).

Corrosion and Erosion

Refer also to abstracts 38320, 38584, and 38878.

38898 (CONF-720109–1) THERMAL INTERACTION BETWEEN WATER AND MOLTEN ALUMINIUM UNDER IMPACT CONDITIONS IN A STRONG TUBE. Darby, K.; Pottinger, R. C.; Rees, N. J. M.; Turner, R. G. (United Kingdom Atomic Energy Authority, Foulness (England)). [nd]. 20p. Dep. NTIS (U. S. Sales Only).

From Meeting on sodium-fuel interaction in fast reactor safety; Grenoble, France (25 Jan 1972).

Results of experiments designed to evaluate the thermal reactions between water and molten aluminum are reported. Descriptions are included of equipment design. Results of tests involving Al at 710°C and water at 20°C are included along with similar tests involving water at 20°C and lead at 473 to 820°C. (J.R.D.)

38899 (CONF-720515–1) MECHANICAL PROPERTIES OF SCALES AND THEIR INFLUENCE ON HIGH-TEMPERATURE GAS–METAL REACTIONS. Cathcart, J. V. (Oak Ridge National Lab., Tenn.). 1972. 22p. Dep. NTIS.

From fourth annual Spring meeting of the Metallurgical Society of AIME; Boston, MA. (8 May 1972).

It is shown that surface stresses between 10^5 and 10^6 psi are frequently generated during oxidation of metals, and several stress generating mechanisms are discussed. The influence of such stresses on scale rupture, structure, and morphology, on diffusion rates within the scales, and on the shape change experienced by oxidation specimens is pointed out. Evidence for extensive high-temperature plasticity in oxides is cited, and the oxidation behavior of two U-base alloys is described by way of emphasizing the importance of the mechanical properties of scales in gas-metal reactions. (auth)

38900 (EURFNR–965) INFLUENCE OF COLD WORKING ON THE CORROSION RESISTANCE OF AUSTENITIC CrNi STEELS IN SUPERHEATED STEAM. 1. STATIC AND SEMIDYNAMIC INVESTIGATIONS OF THE INCOLOY 800 ALLOY. Leistikow, S.; Pott, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translation of report KFK–1476. 32p. (CONF-710648–1). Dep. NTIS.

From German Society for Metal Science meeting; Lausanne, Switzerland (2 Jun 1971).

Work performed under United States–Euratom Fast Reactor Exchange Program.

38901 COATING METAL. Jenkins, Walter Norman; Williams, Terence (to British Iron and Steel Research Assoc.). British Patent 1,272,133. 26 Apr 1972. Filed 23 Sep 1969.

Reference is made to the production of metal sheet or strip having a protective coating, and particularly to the production of coated steel sheet or strip. In conventional processes rolling oil is applied to the rolls, and a film of this oil remains on the surface of the sheet or strip, necessitating subsequent cleaning. It has been discovered that by selection of an appropriate lubricating fluid and subsequent irradiation treatment the need to remove residual fluid film by cleaning can be dispensed with. This fluid should be capable of irradiation cross-linking or polymerization which hardens the coating to provide a protective layer on the metal. Thus the process not only dispenses with the need to clean the rolled material, but also provides a protective coating. A second similar coating is preferably applied. Suitable fluids include polyethylene, liquid paraffin, palm oil, dioctyl sebacate, or certain rolling oils. The sheet or strip may be heated to assist polymerization or cross-linking. (UK)

38902 CORROSION OF PRE-STRESSING WIRES OF CONCRETE PRESSURE VESSELS. Hollingum, P. J. Brit. Engine Tech. Rep.; 10: 87-93(1971).

On-site and laboratory investigations of serious corrosion of concrete-prestressing tendons stored in the bottom-cap ducts of nuclear reactor pressure vessels are reported. The strands had been hot-sprayed with the specified protective grease, areas of which had become emulsified under the storage conditions. The studies revealed pitting under these areas and elsewhere, and results of microprobe and x-ray analyses indicated the involvement of currents such as could arise from welding sets. Avoidance of greases emulsifiable under site conditions, close supervision of welding operations, and verification of the suitability of earth return paths are recommended. (Metals Abstr.)

38903 KINETIC STUDIES ON THE GROWTH OF ANODIC OXIDE COATINGS ON URANIUM IN BASIC MEDIA BY DIRECT CURRENT INTERFERROMETRIC METHOD. Jouve, G.; Aucouturier, M.; Lacombe, P. (Univ. Paris, Orsay, France). J. Nucl. Mater.; 39: No. 3, 339-44(Jun 1971). (In French).

A method is described for studying the kinetics of the growth of oxide coatings during the course of potentiostatic treatment of samples. The method was used to study the kinetics of the growth of oxide coatings formed on uranium in basic media at pH 13 and 14. (P.C.H.)

38904 ANODIC POLARIZATION OF TUNGSTEN IN NEUTRAL AND ALKALINE SOLUTIONS UNDER CONDITIONS OF ANODE FILM GROWTH. Ammar, I. A.; Salim, R. (Univ. of Cairo). Werkst. Korros.; 23: No. 3, 161-7(Mar 1972).

Anodic polarization of W has been studied in neutral (Na_2SO_4, NaCl) and alkaline solutions (ammonium borate, Na_2CO_3, Na_3PO_4, and NaOH) by the galvanostatic method under conditions which led to anode film growth. The rate of oxide growth has been calculated as a function of current density, nature, and concentration of electrolyte. Film growth to potentials above 100 V was achieved in alkaline solutions, provided the solution was dilute and the current density was high. The applicability of the high field ionic conduction has been verified from the dependence of both reciprocal capacity and potential on the logarithm of current density. Data are recorded for the coulometric increase of oxide thickness, the constants of the exponential law, and the electric field. The valve-metal behavior of W in neutral and alkaline solutions was established, and results of oxide breakdown are described. (auth)

38905 SPONTANEOUS AND ANODIC OXIDATION OF TANTALUM AND ZIRCONIUM IN PHOSPHATE SOLUTIONS. Ammar, I. A.; Ismail, I. K. (Univ. of Cairo). Werkst. Korros.; 23: No. 3, 168-74(Mar 1972).

Spontaneous and anodic oxidation of Ta and Zr have been studied in 0.1 M solutions of H_3PO_4, NaH_2PO_4, Na_2HPO_4, and Na_3PO_4. Local currents have been calculated from open circuit measurements and polarization data below 10 $\mu A/cm^2$. The dependence of the spontaneous oxidation rate on potential follows a Tafel relation. The results indicate that the partial anodic reaction of film formation is balanced by the cathodic reduction of dissolved oxygen. The kinetics of anodic oxidation are discussed on the basis of a one phase oxide film liable to contamination by phosphate anions. Oxide growth follows the high field ionic conduction even for measurements below the oxygen evolution potential. The simple exponential relation of Güntherschulze and Betz is valid. This is supported by the linearity obtained between (i) reciprocal capacity and the logarithm of current density i, and (ii) the potential E and log i for oxide formation at constant charge. Data are given for the parameters of ionic conduction and the electric field strength. Approximate calculations of the effective activation distance show that the degree of contamination by anions is the same in the four equimolar solutions independent of p_H. (auth)

38906 CORROSION OF STRUCTURAL MATERIALS IN THE BORON-CONTAINING SOLUTIONS USED FOR CONTROLLING THE POWER OF NUCLEAR REACTORS. Margulova, T. Kh.; Bursuk, L. M.; Bogatyreva, S. V.; Lipanina, A. A. (Moscow Power Inst.). Therm. Eng. (USSR) (Engl. Transl.); 17: No. 12, 13-17(1970).

Translated from Teploenergetika; 17: No. 12, 14-17(1970).

An investigation of corrosion of steel and $Zr-2\frac{1}{2}Nb$ alloys in dilute boric acid solutions is described. It was found that the use of boric acid for control of reactors does not increase the corrosion rates for structural materials. When the solution is to be used in contact with steel, the solution should be made alkaline using KOH. Steel is recommended for use in fabrication of boric acid solution storage tanks. (J.R.D.)

38907 INVESTIGATION WITH RADIOACTIVE ISOTOPES OF HIGH PRESSURE VALVE EROSION. Vlasov, P. V. (Odessa Polytechnical Inst.). Therm. Eng. (USSR) (Engl. Transl.); 17: No. 12, 63-6(1970).

Translated from Teploenergetika; 17: No. 12, 47-50(1970).

The erosion of sealing surfaces of steel valves was investigated by tracer techniques. Erosion rates were measured by frequency of radiation pulses downstream from the test valve. Results show that with increased difference between pressures upstream and downstream of the valve, the downstream radiation pulse rate increased 8% in test in which valves designed with stepped seating surfaces were used and 20% in tests of smooth-surface valve seats. (J.R.D.)

38908 AUGER ELECTRON SPECTROSCOPY INVESTIGATIONS OF THE SURFACE CHEMICAL COMPOSITION OF VANADIUM, THE VANADIUM OXIDES, AND OXIDIZED VANADIUM: CHEMICAL SHIFT AND PEAK INTENSITY ANALYSIS. Szalkowski, F. J.; Somorjai, G. A. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 12, 6097-6103(15 Jun 1972).

The Auger spectra of vanadium metal and of the oxides $VO_{0.92}$, V_2O_3, and VO_2 were studied. Chemical shifts on the order of 0.6 eV per oxidation number were observed for the vanadium inner shell Auger transitions. Relative intensities of the oxygen and vanadium Auger peaks could be used to determine the surface composition of the different oxides. Using both the chemical shifts and the oxygen-to-vanadium Auger peak intensity ratios for the different vanadium oxides, the oxidation of vanadium metal to VO and then to V_3O_5 with increasing temperature was observed. (auth)

38909 CONTRIBUTION TO THE ELUCIDATION OF THE ROLE OF SULPHATE IONS IN ATMOSPHERIC CORROSION OF IRON WITH THE USE OF ^{35}S. Kuchynka, D.; Barton, K. (Statni Vyzkumny Ustav Ochrany Materialu, Prague). Radioisotopy; 13: No. 1, 111-38(1972). (In Czech).

In industrial exhausts, corrosion of iron takes place in which SO_2 plays an important role as a corrosion-stimulating factor. The mechanism of the corrosion process has not been clearly determined. The origin of surface agglomerations of iron disulfate and their influence on the corrosion process is not known. New information on the origin, development, and properties of the so-called sulfate nests, where the corrosion stimulator SO_4^{2-} concentrates, have been obtained using ^{35}S in autoradiographic and radiometric evaluation. (auth)

38910 OXIDATION OF NIOBIUM IN OXYGEN AT HIGH TEMPERATURE AND LOW PRESSURES. Ferrari, A.; Pacifici, G. (CNR, Cinisello Balsamo, Italy). Met. Ital.; 63: No. 10, 519-25(Oct 1971). (In Italian).

Reactions during the oxidation of niobium at temperatures from 850 to 1500°C and in a pressure range 10^{-5} to 10^{-4} torr were studied. Two different reactions were observed: interstitial solution of oxygen in niobium and NbO_2 formation and growing of the NbO and NbO_2 phases. The experimentally determined activation energies were found to be 10.3 and 28.1 kcal/mole for the two processes. Furthermore, the pressure dependence of the reactions was investigated. (auth)

38911 PREPARATION OF RADIOACTIVE CRYPTONATES AND THEIR APPLICATION IN CORROSION STUDIES. Doksansky, V. (Statni Vyzkumny Ustav Ochrany Materialu, Prague). Radioisotopy; 13: No. 1, 75-109(1972). (In Czech).

A device was developed and constructed for the preparation of radioactive kryptonates by diffusion of various metallic and nonmetallic materials. The inner diameters of this device (i.e., the maximum dimensions of the kryptonated material) are: diameter: 44 mm and height: 70 mm. Radioactive kryptonates of various materials were prepared and radiometric tests and some orientation trials for corrosion study applications were performed. (auth)

38912 PROTECTIVE METALLIC COATINGS FOR γ-QUENCHED U−5 WT. PERCENT Nb ALLOY. McLaughlin, B. D. (Sandia Labs., Albuquerque, N. Mex.); Panousis, N. T. J. Nucl. Mater.; 43: No. 3, 343-6(Jun 1972).

A feasibility study regarding the possible protective capabilities of active metal coating was prompted by the discovery that cathodic polarization effectively inhibits the initiation of stress corrosion cracks in dilute chloride solutions ($\sim 10^{-4}$ N KCl), regardless of aging time, aging temperature, or applied stress. Various tests were performed to investigate the validity of the speculation that either the incubation period will be extended or crack initiation will be inhibited altogether by coating the alloy with an active metal. The results showed that electrodeposited Cd, as well as Al deposited by PVD, CVD, and plasma spraying, substantially extended the incubation period for the stress corrosion cracking of γ-quenched U−5 wt% Nb alloy, in dilute chloride environment. No attempt was made to develop continuous, impermeable coatings that would protect the U−5 wt% Nb by precluding its contact with a hostile environment. (P.C.H.)

38913 EFFECTS OF CARBON CONTENT ON STRESS CORROSION OF U−Mo ALLOY WITH 10% BY WEIGHT Mo IN HUMID AIR AT 20°C. Beaubron, M. A. (CEA-DAM, Is-sur-Tille, France). J. Nucl. Mater.; No. 3, 351-3(Jun 1972). (In French).

Studies were made on the susceptibility of stress corrosion of cylindrical pieces of U−Mo 10% in humid air as a function of their carbon content. The results showed that the ruptures were placed perpendicularly to the direction of the constraint; their appearance was generally transgranular. Nevertheless, on a cylinder with 100 ppM carbon, broken after 1.6 h, a characteristic intergranular cracking was observed. Other results are also discussed. (P.C.H.)

38914 PLUTONIUM OXIDATION IN MOIST OXYGEN–NITROGEN MIXTURES. Stakebake, J. L.; Steward, L. M. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Electrochem. Soc.; 119: No. 6, 730-5(Jun 1972).

Plutonium oxidation studies were conducted at 90°C in dry air and moist oxygen–nitrogen mixtures using both cast and rolled plutonium. Oxidation in dry air obeyed a linear rate law with average rate constants of 0.042 and 0.050 mg/cm^2hr for the cast and rolled plutonium, respectively. Both metal samples were found to oxidize faster in the moist oxygen mixtures than in moist nitrogen. Linear oxidation rates were observed in moist oxygen–nitrogen mixtures with average rate constants of 0.68 and 0.34 mg/cm^2hr for the cast and rolled plutonium. In moist nitrogen oxidation followed a parabolic rate law with average rate constants of 3.60 and 1.11 $mg/cm^2hr^{1/2}$ for the cast and rolled samples, respectively. The reaction with water vapor observed during this investigation was greatly influenced by the purity of the metal as well as its metallurgical history. Samples of cast, electrorefined plutonium containing some microcracks reacted very rapidly, while for the relatively impure rolled material the reaction was somewhat slower. In all cases at this temperature, the reaction with water vapor was diffusion controlled and not reaction controlled as has been reported previously. The diffusing species is believed to be OH^- ions formed by the dissociative adsorption of water on plutonium dioxide. (auth)

38915 OXIDATION OF BETA-PHASE PLUTONIUM. Lindsay, J. W.; Terada, K.; Thompson, M. A. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Electrochem. Soc.; 119: No. 6, 726-9(Jun 1972).

Oxidation of β-phase plutonium was studied by hot-stage x-ray diffraction, microtopography, and thermogravimetry. The oxidation process was found initially to proceed by the formation of a protective sesquioxide film. Subsequently, the protective film was destroyed by blistering and the reaction rate accelerated. (auth)

38916 INVESTIGATION OF CORROSION PRODUCT DEPOSITS ON REACTOR FUEL RODS. Henzel, Norbert; Schuck, Volker; Lindner, Ursula (AEG-Telefunken, Grosswelzheim, Ger.). At. Strom; 18: No. 3-4, 64-6(Mar-Apr 1972). (In German).

Corrosion product deposits as known from fossile fuel power plants, also occur in nuclear steam generation systems, e.g., on the fuel rods of water-cooled reactors. A prerequisite for investigating those deposits are representative sampling techniques which can be applied during post-irradiation inspection in hot cells and "on the spot," i.e., in the fuel element pool. For both possibilities, devices and procedures were developed and tested with elements of three boiling-water reactors. (auth)

Preparation and Fabrication

Refer also to abstracts 38357, 38892, 39011, and 39047.

38917 (CONF-720605–1) ELECTRON BEAM FLOAT ZONE MELTING AND VACUUM DEGASSING OF NIOBIUM SINGLE CRYSTALS. Reed, R. E. (Oak Ridge National Lab., Tenn.). May 1972. 24p. Dep. NTIS.

From Vacuum metallurgy conference; Pittsburgh, PA. (19 Jun 1972).

Niobium metal powder produced by electrodeposition from molten salts by CIBA Ltd. was electron beam float zone melted (EBFZM) for purification and growth of single crystals. It was necessary to EBFZM with a high oxygen partial pressure to reduce the carbon level. A high resistance ratio [$R_{300°K}/R_{4.2°K(15\ kgauss)}$ = 6500] and low flow stress [τ_{1y} = 460 gm/mm^2] was obtained after a high temperature anneal (2350°C) in high vacuum (2×10^{-10} torr). Extensive material characterization results are reported for the niobium at various stages in the purification process. The impurity content determined by chemical analyses did not correlate with the resistance ratios; however, the flow stress exhibited an excellent correlation with resistance ratio. These results imply that interstitial impurity in solid solution is the impurity distribution most affecting dislocation motion. (auth)

38918 (RDT-M–3-6-T(6-72)) AUSTENITIC STAINLESS STEEL PIPE (ASME SA-312 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1972. 11p. RSO.

A standard prescribing requirements for austenitic stainless steel pipe (ASME SA-312 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 3-6T dated July 1971. (J.R.D.)

38919 (RDT-M–3-26-T(2-72)) SEAMLESS AUSTENITIC STAINLESS STEEL TUBES WITH INTEGRAL FINS. (ASTM A498 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Feb 1972. 9p. RSO.

A standard prescribing requirements for seamless austenitic stainless steel tubes with integral fins is discussed. (ASTMA 498 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

38920 (RDT-M–4-2-T(6-72)) AUSTENITIC STAINLESS STEEL CASTINGS (ASME SA-351 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1972. 11p. RSO.

A standard prescribing requirements for austenitic stainless steel castings (ASME SA-351 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 4-2 T, dated July 1971. (J.R.D.)

38921 (RDT-M–5-2-T(6-72)) CARBON STEEL PLATES (ASME SA-516 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jun 1972. 9p. RSO.

A standard prescribing requirements for carbon steel plates (ASME SA-516 with additional requirements) for nuclear and associated applications is presented. This standard supersedes RDT M 5-2T dated July 1971. (J.R.D.)

38922 (RFP–1835) FABRICATION OF ^{242}Pu METAL DISKS. Conner, William V.; Proctor, Stephen G.; Baaso, Donald L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 19 May 1972. Contract AT(29-1)-1106. 7p. Dep. NTIS.

The preparation of three ^{242}Pu metal target disks is described. The disks were 1.00 ± 0.010 inch in diameter and 0.010-, 0.040-, and 0.180-inch thick. The disks were prepared using casting techniques. The variation in the thickness for each disk was within 3% of the disk's average thickness. The conversion of the $^{242}PuO_2$ to metal and the recovery of the metal reduction and casting residues are also described. (auth)

38923 (WARD–4210-T-3-5) TOPICAL REPORTS. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jul 1971. Contract AT(30-1)-4210. 123p. Dep. NTIS.

Results of testing Type 316 stainless steel for use as fuel cladding are presented in two sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 38924 and 38943.

38924 (WARD–4210-T-3-5, pp 2.1-19) CLADDING WELDABILITY STUDY. Elliot, D. N.; Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jul 1971. In Topical reports.

A study was conducted to evaluate the effects of processing and fabrication variables on the weldability of Type 316 stainless steel fuel pin cladding. The program was limited to making test welds in different grades of Type 316 stainless steel cladding, with a constant set of weld parameters typical of those used in fuel pin end-closure welding. A total of 261 test welds were made, using semi-automatic tungsten inert gas welding; the test welds were examined using radiography, helium leak testing, metallography, visual examination, and dimensional inspection. The results obtained indicate that with 0.0015-inch end plug–tube interferences, the annealed material exhibits a 0.9% defect rate as compared with a 6.5% defect rate with 15 to 20% cold worked material. However, with no end plug-tube interference, the annealed material exhibits a 13% defect rate as compared to a 0% defect rate with 15 to 20% cold worked material. (auth)

38925 WORKING AND PROCESS-ANNEALING OF DOPED TUNGSTEN WIRES. Yamamoto, Hiroshi (Hitachi Ltd., Tokyo). J. Jap. Inst. Metals; 36: No. 4, 310-15(Apr 1972). (In Japanese).

Filaments of incandescent lamps are recrystallized and become brittle when lighted. It is necessary that the brittleness of the filaments be decreased in order to improve and stabilize the performance of lamps. The effects of the annealing in the drawing process on the recrystallization of wires were examined to establish the conditions for producing ductile filaments. Samples used were 2 kinds of tungsten wires doped with K, Si, and Al. One was drawn to diameters of 0.055 to 0.207 mm without process-annealing. The other was drawn to a final diameter of 0.089 mm by changing the process-annealing. Tensile strength and structure changes of these samples after recrystallization were investigated. The experiments revealed that the drawing with a proper process-annealing gave fairly high tensile strength and recrystallization temperature to the drawn wires. The proper process-annealing was the heat treatment which was done twice in the process to reduce the tensile strength of the as-drawn wires by about 10 percent each time. Furthermore, it was found that the wires with a fairly high recrystallization temperature became rather ductile after recrystallization. The filaments made from the wires that had been treated under various conditions of process-annealing were subjected to tensile test after heating for recrystallization at higher temperature than the usual lightening temperature of the filaments, and the above-mentioned conclusion was confirmed to be valid. (auth)

38926 COBALT-BASE SUPERALLOYS PRODUCED FROM POWDER. Morral, F. R. (Cobalt Information Center, Columbus, Ohio). Planseeber. Pulvermet.; 20: No. 1, 3-19(Mar 1972).

From the information presented it is clear that in powder metallurgy, a wide choice of parameters is available with which to control final products, and obtain desirable properties. The effects obtainable and the controls required for some of these parameters, as they relate to cobalt-base alloys, are not as yet well known although considerable experience is being gained by the investigations and development work being carried out on other alloys, particularly nickel-base superalloys. This experience, as well as that already gained on the cobalt-base superalloys are briefly reviewed and should be useful for the development of improved powder metallurgy cobalt superalloys and parts. (auth)

38927 STRUCTURAL PECULIARITIES OF WELD METAL IN WELDING THIN-SHEET MOLYBDENUM. D'yachenko, V. V.; Morozov, B. P. Avtomat. Svarka; No. 7, 24-6(Jul 1971). (In Russian).

The effect of welding speed and technique on the character of a welded seam was studied in connection with the joining of sheet molybdenum alloys (0.5 to 1.0 mm thick), designated as VM1D and TSM2a. The plasticity of a seam in sheet Mo at various welding speeds, and the technique of introducing heat during welding, basically depend on orientation and form of the grain boundary in the seam. (tr-auth)

38928 ELECTROLYTIC PREPARATION OF TUNGSTEN POWDER. Suchkov, A. B.; Rumyantseva, G. V.; Demachev, A. R ; Zhukova, N. V. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 12, 941-2(Dec 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 12, 1-3(Dec 1971).

Pure metallic tungsten powder was prepared under laboratory conditions by the two-stage electrolysis method, consisting of the electrolytic reduction of Scheelite concentrate and the electrorefining of the resultant product in fused media. It was found that electric power consumption in the electroreduction and electrorefining operations is relatively low (20 kWh/kg of metal). The overall extraction of tungsten was 78%. (auth)

38929 PROCESS FOR THE PREPARATION OF TANTALUM POWDER. Daendliker, Gustav (to Ciba Ltd). Australian Patent 418,501. 3 Nov 1971. Priority date 2 Feb 1966, Switzerland.

Tantalum powder was prepared by the reduction of tantalum oxide with carbon in a high vacuum. The reduction was performed in 2 stages and at temperatures below 2000°C with the starting material being as stoichiometric as possible with a slight carbon excess being permissible. Between the first and second reaction stages the oxidation deficiency was alleviated by oxidation. (Australia)

38930 PREPARATION OF THORIUM–MAGNESIUM ALLOYS AND PURE THORIUM BY MAGNESIUM REDUCTION OF THORIUM TETRACHLORIDE. Campbell, T. T.; Robidart, G. B.; Block, F. E. Report of Investigation No. 7569. Washington, D. C.; Bureau of Mines (1971). 17p.

Studies were conducted by the Bureau of Mines to develop a process for preparing Th–Mg master alloys or pure Th metal by Mg reduction of thorium tetrachloride in a semicontinuous reactor. Thorium tetrachloride was prepared in a fluidized-bed reactor by chlorination of thorium oxide or thorium oxalate. Conditions were established for producing a suitable thorium oxide feed for a fluidized-bed reactor. Thorium tetrachloride was purified by vacuum sublimation and subsequently reduced by Mg in a semicontinuous reactor to form Th–Mg alloys. Relatively pure Th was produced by removing Mg from the alloys by vacuum sublimination. Close to 100% of the Th fed into the reactor was recovered either as metal (~93%) or as thorium oxide (~7%). The oxide can be recycled directly into the process. (Metals Abstr.)

38931 HIGH-PRESSURE SYNTHESIS OF RARE EARTH–TRITIN COMPOUNDS. Miller, Karl; Hall, H. Tracy (Brigham Young Univ., Provo, Utah). Inorg. Chem.; 11: No. 6, 1188-91(Jun 1972).

New rare earth–tritin compounds of face-centered cubic structure ($AuCu_3$ type) were prepared for Tb, Dy, Ho, Er, and Y. Pressures to 85 kbars concurrent with temperatures to 1400° were employed in the studies. Analogous compounds were not found for the Lu–Sn and Sc–Sn systems. (auth)

38932 ELECTRODEPOSITION OF TUNGSTEN ALLOYS. Sarojamma, M.; Rama Char, T. L. Metal Finish.; 69: No. 10, 56-62(Oct 1971).

This comprehensive review of plating baths for W alloys covers the following: bath composition, pH, temperature, cathode efficiency, and resulting deposit composition during electrodeposition of binary Ni, Co or Fe alloys; deposition parameters for ternary alloys and the effect of bath composition, temperature, pH, and other deposition parameters on the deposit, composition; and cathode efficiency during plating from acid and alkaline baths. (Metals Abstr.)

38933 WELDABILITY OF SOME MOLYBDENUM ALLOYS. Gurevich, S. M.; Nerodenko, M. M.; Alekseenko, G. N.; Biryukova, T. A.; Shchukin, A. A. Avtomat. Svarka; No. 3, 27-9 (Mar 1971). (In Russian).

An investigation of the weldability of Mo–C, Mo–C–Fe, Mo–C–Co, Mo–C–Ni, and Mo–C–Ir alloys was carried out with W electrodes on 1 mm sheet; after welding the joints were bend tested. The alloying elements improved the plasticity of the joints by refining the structure of the weld seams. Ni and Ir had the greatest effects. (Metals Abstr.)

Properties, Structure, and Phase Studies

Refer also to abstracts 38329, 38347, 38378, 38857, 38859, 38877, 38879, and 40141.

38934 (CONF-720319–2) EXAMINATION OF IRRADIATED REACTOR CLADDING AND STRUCTURAL MATERIALS BY ELECTRON MICROSCOPY. Fulton, E. J.; Cawthorne, C. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). [nd]. 4p. Dep. NTIS (U. S. Sales Only).

From Conference on post-irradiation examination techniques; Reading, England (22 Mar 1972).

Specimens are examined using a 200 KV JEM 200A electron microscope giving good results with foils up to 5000 Å in thickness. This is a useful feature particularly for specimens having large voids since proper evaluation of a micrograph requires that most of the voids be wholly contained within the foil. Void sizes are measured from micrographs using an SPRI particle size analyzer. This consists essentially of a ruler having a tapered slot and a row of electrical contacts which operate an eight hole tape punch when touched by a wandering electrode. The ruler is positioned so that the void just fills the tapered slot and the nearest electrode is contacted. The tape is then used as input data to an ICL 4-70 computer which performs all the required calculations and plots a void size distribution graph. For this purpose voids are considered spherical, and markedly elongated voids cannot be assessed using this method. In the case of voids having uniform polyhedral shapes the computer program may be modified to calculate void volume from one of the principle void dimensions. The calculation of void concentration (i.e., number of voids per unit volume of metal) requires a knowledge either of the density change of the material or the foil thickness. Of these, density change gives the more accurate result for specimens having a void volume greater than ~0.5%. An apparatus for density determination is available capable of dealing with specimens from 30 mg to 10 g in weight. For cases where this method cannot be used, (e.g. where the void population is thought to be unhomogeneous, so that a bulk density determination cannot be assumed to be representative of the particular piece of foil being examined) the void concentration is calculated using a measured foil thickness which may be obtained by either of two methods depending on the characteristics of the particular foil being examined. If a slip band or coherent twin boundary is visible in the field of observation, the foil thickness may be easily obtained in the normal way. Failing this the thickness is calculated from the displacement of features close to the foil surfaces in stereo pair micrographs. In cases where total void volume has been calculated using both density and foil thickness measurements, the results have usually agreed within 20%. (auth)

38935 (COO–2107-5) CORRELATION OF SUBSTRUCTURE WITH MECHANICAL PROPERTIES OF PLASTICALLY DEFORMED AISI 304 AND 316 STAINLESS STEEL. Progress Report, October 1, 1971–December 31, 1971. Moteff, J. (Cincinnati Univ., Ohio. Dept. of Materials Science and Metallurgical Engineering). 15 Feb 1972. Contract AT(11-1)-2107. 46p. Dep. NTIS.

A program to evaluate the substructure of austenitic stainless steels (316 and 304) deformed at elevated temperatures in the creep, tensile, and fatigue modes is being conducted. Transmission electron microscopy is the primary tool employed in this research. Complementary work using optical microscopy and immersion density is presently underway to characterize the grain boundary microcracks and bulk density change observed subsequent to deformation in these materials. The substructure resulting from tensile deformation is found to contain dislocation cells and evidence of planar slip for deformation below 0.5 T_m and subgrains for deformation above 0.5 T_m. The substructure of the specimen tested at ~0.5 T_m exhibits evidence of subgrain formation in regions near grain boundaries. Electron micrographs representative of the substructure are presented. The average subgrain and dislocation cell intercepts, d, and mobile dislocation density, ρ_m, are related to the maximum true tensile stress, σ, by $d \alpha \sigma^{-1}$ and $\rho_m^{\frac{1}{2}} \alpha \sigma$, respectively. The hot-microhardness of the shoulder portion of the tensile specimen tested at 21°C shows a definite recovery of prior, unrecovered deformation. This result is in agreement with the substructure of the shoulder which indicates the presence of unrecovered deformation. A detailed literature review on intergranular crack formation during the elevated temperature plastic deformation of polycrystalline metals was completed. A condensed version of this review is presented. The microcrack length distribution of 304 stainless steel tensile tested at 650°C and at three strain rates indicates that the majority of cracks are one grain boundary facet in length. The measured crack percentage angular distribution as a function of angle from the tensile axis shifts toward higher angles with decreasing strain rate. Micrographs which illustrate the observed cracks are presented. (auth)

38936 (HEDL-TME-71-86) ELASTOMER COMPATIBILITY WITH LIQUID SODIUM AT 450°F. Antal, E. F. (Hanford Engineering Development Lab., Richland, Wash.). Jun 1971. Contract AT(45-1)-2170. 10p. Dep. NTIS.

Three materials were used for compatibility testing with liquid sodium: silicone rubber; ethylene propylene; and polyimide. The ethylene propylene's recommended operational temperature of 350°F limited it to a brief compatibility test. Data on polyimides and a sample of a Dupont polyimide, "Vespel," showed that this material was a rigid plastic and could not function as an elastomer O-ring. Silicone O-rings with a ferric oxide heat stability additive were affected by liquid sodium at 450°F. Sodium vapor also affected the O-rings, but to a lesser degree. The strength loss noted in these tests was primarily caused by heat aging. Silicone O-rings would have a limited useful life as an elastomer seal in contact with sodium/sodium vapor at temperatures of 450°F. The silicone apparently goes into solution in the liquid sodium at these temperatures. The effects of this contamination should be determined. Further tests should be undertaken with pressurized sodium systems at temperatures to determine the useful life of silicone O-rings. (auth)

38937 (JPRS-56001) RESEARCH ON METALS AND ALLOYS. Translation of articles from Izv. Akad. Nauk SSSR, Metal.; No. 1, 1972. 30p. NTIS.

Three articles are included; a separate abstract was prepared for two. The remaining article on embrittlement of martensite-aged 00N18K9M5T steel by precipitation of titanium carbonitrides was not in scope for NSA. (P.C.H.)

For abstracts of individual papers see: 38938 and 38939.

38938 (JPRS-56001, pp 12-22) DISTRIBUTION OF TRANSITION ELEMENTS FROM THE IV-VI AND VIIIa GROUPS BETWEEN γ- AND γ'-PHASES OF HEAT-RESISTANT NICKEL ALLOYS. Kishkin, S. T.; Kozlova, M. N.; Lashko, N. F. Translated from Izv. Akad. Nauk SSSR, Metal.; No. 1, 170-6(1972).

Studies were made on the γ- and γ'-phases in real metastable heat-resistant alloys containing other phases in addition to the disperse particles of the γ'-phase. The results showed that the composition of the γ'-phase on an Ni_3Al base in heat-resistant Ni-Cr alloys was specific for each alloy. The Al: Ti ratio in the γ'-phase of these alloys was near their ratio in the alloy. The capacity of the elements of the transition groups for formation of the γ'-phase determined from the ratio of the content in the γ- and the γ'-phases dropped with increase in the number of the group of the period system (with the exception of Co). In the limits of the given group the γ'-forming capacity of the element grew with increase in the period (V and VI groups). The replacement in the alloy of part of the Al by Ti caused a decrease in the amount of elements from the VIa group in the γ'-phase and an increase in their content in the γ-phase, respectively. (P.C.H.)

38939 (JPRS-56001, pp 23-30) INVESTIGATION OF THE INTERACTION OF Nb-Mo ALLOYS WITH BORON. Zhunkovskii, G. L.; Braun, S. M. Translated from Izv. Akad. Nauk SSSR, Metal.; No. 1, 188-92(1972).

Studies were made on the interaction of alloys in the system Nb-Mo with boron. The results showed that the rate of the interaction is determined by the percentage content of components in the alloy. In the temperature range of 1100 to 1400°C the rate of growth of the boride phases in the alloys with 20 to 50% Mo was 4 to 6 times less than in pure Nb and Mo. Conclusions were made as to the prospects of these alloys for operation at high temperatures in boron-containing media. (P.C.H.)

38940 (RD/B/N-2242) KIKUCHI MAP FOR THE HEXAGONAL CLOSE-PACKED STRUCTURE. Gelles, D. S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1972. 10p. Dep. NTIS (U. S. Sales Only).

A complete Kikuchi Map is presented for the hexagonal close-packed crystal structure using a sample of magnesium - 0.71 wt% manganese (Magnox Mn70). It is compared with the magnesium stereographic projection and three useful applications are given: sample orientation, sample reorientation for Burgers vector determination, and stereo pairs construction. (auth)

38941 (RD/B/R-2146) GENERAL EQUATION FOR THE SOLUBILITY OF OXYGEN IN LIQUID SODIUM. Noden, J. D. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1972. 17p. Dep. NTIS (U. S. Sales Only).

Existing published data on the solubility of oxygen in liquid sodium were correlated using the least-squares method. Selected data of 169 individual analyses were used to derive the solubility curve, described by the general equation: $\log_{10}[0]_{wppm} = 6.1587 - 2386.4/T(°K)$. This equation is recommended for fast reactor work. (auth)

38942 (RFP-1814) CHARACTERIZATION STUDIES OF PHYSICAL VAPOR-DEPOSITED BERYLLIUM. Mah, George; Nordin, Carl W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 17 May 1972. Contract AT(29-1)-1106. 7p. Dep. NTIS.

Beryllium flat foils of 0.5 to 5 mils thick and shapes of 3 to 4 mils thick have been produced by thermal evaporation, utilizing an electron-beam gun for heating. A study was made of the relationship between the substrate temperature during deposition and the microstructure of the resulting foils. An absence was noted of cone growth in the foils which were deposited at high substrate temperatures (>400°C). The foils show an (0002) preferred orientation. Physical and mechanical properties (electrical resistivity, fracture strength, total elongation, and hardness) of the foils were measured as a function of the substrate temperature. The effects of thermal treatments on the foils are reported. (For metric use: 1 mil = 3×10^{-5} meters.) (auth)

38943 WARD-4210-T-3-5, pp 1.1-94) STRUCTURAL CHARACTERIZATION AND BIAXIAL MECHANICAL PROPERTIES OF VACUUM-MELTED TYPE 316 STAINLESS STEEL TUBING. Padden, T. R.; Ray, W. E.; Tarby, E. J.; Thomas, K. C. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jul 1971.

In Topical reports.

Results of investigations of Type 316 stainless steel properties for use as oxide fuel pin cladding for LMFBR are summarized. The studies are concerned with unirradiated properties but directed to properties identified as basically influencing in-pile behavior. These include grain size, cold work, melting processes, texture, dimensional variations, and surface defects. (J.R.D.)

38944 PHASE DIAGRAM OF THE SYSTEM ZIRCONIUM-OSMIUM WITHIN THE REGION OF 50 TO 100 AT. PERCENT OSMIUM. Eremenko, V. N.; Shtepa, T. C.; Semenova, O. L. (Inst. of Problems in Material Science, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 1, 50-2(Jan 1972). (In Ukrainian).

By metallographic and x-ray measurement of melting temperatures of the alloy, a phase diagram is plotted for the zirconium-osmium system within the region of 50 to 100 at.% osmium. The phase $ZrOs_2$ melts congruently and ZrOs incongruently at temperatures of 2660 and 2040°C, respectively. The phase $ZrOs_2$ with a solid solution on the osmium base forms eutectics at t = 2440°C. The eutectic composition is ~81 at.% Os. (auth)

38945 MEAN FREE PATH AND PARTICLE DISTRIBUTION STUDIES IN SOME NICKEL-THORIA ALLOYS. Ahmad, S. A.; Davies, T. J. (Univ. of Manchester, Eng.). Planseeber. Pulvermet.; 19: No. 3, 159-68(Sep 1971).

The measurement of particle size and interparticle spacing is an important exercise in the understanding of the mechanical behavior of dispersion-hardened alloys. It is shown that the original method of E. Scheil can be used to obtain the distribution of particles of thoria in a dispersion strengthened nickel alloy. A spectrum of interparticle spacing is obtained by incorporating Scheil's method with a formula describing the interparticle spacing. Measurements were made on three alloys containing 0.1, 1.0 and 3.0 volume percent thoria, which were prepared from a known initial size of thoria particles. The experimental results were computerized and are interpreted in terms of particle size and interparticle spacings. Results of volume percents show a good correlation between computed and true values for the 1.0 and 3.0 volume percent alloys. Reasons for deviation in the values for the 0.1 volume percent alloy are discussed. It is suggested that the gradient of the plot for particle diameters against interparticle spacing may be used as an indication of the degree of mechanical work of the alloy. (auth)

38946 FORMATION OF INTERNAL HYDRIDES IN ALLOYS. I. ON THE KINETICS AND EQUILIBRIA OF THE FORMATION OF INTERNAL HYDRIDES IN MAGNESIUM ALLOYS. Renner, J.; Grabke, H. J. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 63: No. 5, 289-94(May 1972). (In German).

Homogeneous alloys of magnesium with minor amounts of some hydride forming metal such as Th, Zr, or Li have been hydrogenated in the temperature range 450 to 550°C. The hydrogen absorption in these alloys has been studied by a volumetric method at different constant pressures up to 1 atm H_2. Very small particles are formed in the case of ThH_2 or ZrH_2 precipitation (about 25 Å), larger particles in the case of LiH. For thin samples the transfer of hydrogen through the magnesium surface determines the rate of hydrogen absorption. The rate equation and the activation energy of 45 kcal/mole H could be determined. Furthermore it may be derived from the kinetics that there is segregation of interstitial hydrogen at the surface of magnesium. (auth)

38947 PINNING EFFECT OF MICROPORES ON THE GRAIN BOUNDARY MOTION DURING RECRYSTALLIZATION OF DRAWN TUNGSTEN WIRES. Horacsek, Otto (Research Inst. for Technical Physics, Budapest). Z. Metallk.; 63: No. 5, 269-73(May 1972). (In German).

The formation of elongated grains in doped, creep-resistant tungsten wires may be ascribed in part to the pinning effect of rows of pores which are lined up parallel to the wire axes on the recrystallization. Based upon the size and distribution of the pores the local repulsive force p* in the rows of pores was determined which is effective during the recrystallization whose driving force is p. The repulsive force can amount to 10^8 dynes/cm^2 and can, thus, exceed the maximum driving force of primary recrystallization. During secondary recrystallization the grain boundary is pinned along several points parallel to the wire axis, since the driving force is less by one order of magnitude. Therefore, the grain growth proceeds in neighboring areas which are almost completely isolated from each other by the rows of pores. (auth)

38948 REDUCTION OF NABARRO—HERRING CREEP AND SINTERING RATES BY OXIDE DISPERSIONS. Easterling, Kenneth E.; Gessinger, Gernot H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 63: No. 5, 237-40 (May 1972).

In metals containing oxide inclusions, rates of creep and sintering are reduced below those in pure metals. An attempt is made to explain this phenomenon, based on a diffusional mechanism of inclusion movement through the matrix. The theory predicts that provided the inclusions can be well anchored, e.g., by dislocation networks, diffusional creep and sintering rates may be effectively reduced, in agreement with experiment. (auth)

38949 KINETICS OF THE DECARBURIZATION OF NIOBIUM IN FLOWING OXYGEN TO FORM CARBON MONOXIDE. Hoerz, Gerhard; Lindenmaier, Klaus (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk.; 63: No. 5, 240-7(May 1972). (In German).

Thin niobium wires (0.5 mm dia) with concentrations of dissolved carbon between 0.3 and 1 at.% have been decarburized at temperatures between 1600 and 2120°C in flowing oxygen at partial pressures between 2×10^{-6} and 3×10^{-5} torr. The decarburization reaction has been followed by continuously measuring the electrical resistivity of the specimens and the carbon monoxide partial pressure in the reaction chamber. At short reaction times (reaction range I) the rate of the decarburization ν_c is determined by the rate of oxygen transport to the specimen surface and chemisorption of oxygen. In the reaction range I practically no oxygen is dissolved in niobium. At longer reaction times (reaction range II) ν_c is determined by the diffusion of carbon in niobium to the specimen surface and oxygen is dissolved in niobium. (auth)

38950 INTERACTION OF URANIUM WITH INORGANIC HALIDES. Beard, J. H.; Orman, S.; Robertson, P. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Nucl. Mater.; 39: No. 3, 330-4(Jun 1971).

The interaction of uranium with a series of inorganic halides in aqueous and organic solvents has been studied. Transition metal halides in their highest oxidation state and aluminum chloride react readily with uranium metal, the uranium going into solution in the U(IV) state. The transition metal halides in a lower oxidation state were without effect on uranium. Other metal salts, including transition metals associated with acid radicals other than halides were similarly without effect. The results are discussed and possible uses of the reactions suggested. (auth)

38951 REDISTRIBUTION OF PLUTONIUM AND URANIUM IN MIXED (U,Pu) OXIDE FUEL MATERIALS IN A THERMAL GRADIENT. Bober, M.; Sari, C.; Schumacher, G. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 39: No. 3, 265-84(Jun 1971).

The redistribution of plutonium and uranium has been investigated in mixed ($U_{0.85}Pu_{0.15}$) oxide fuel materials subjected to a temperature gradient in laboratory experiments. The cylindrical specimens in sealed tungsten containers were exposed to temperatures up to 2,800°K and longitudinal temperature gradients up to 2,000°K/cm. The structures which developed in the specimens were correlated exactly with temperature. An inspection by alpha-counting of the specimens after thermal treatment showed a decrease of plutonium in the columnar grain region and an accumulation at the high-temperature end. Three redistribution processes were indicated and are discussed in detail. Each of them caused a characteristic distribution of plutonium concentration. The processes were: preferential evaporation at the surface of the specimens; preferential evaporation and condensation in migrating voids; and thermal diffusion. For thermal diffusion a heat of transfer of 35 kcal/mole was estimated and long time effects were calculated. In conclusion, corresponding effects of the redistribution processes in reactor fuel elements are discussed briefly. (auth)

38952 MECHANISM OF SELF-DIFFUSION IN PLUTONIUM FCC θ PHASE. Calais, D.; Zanghi, J. P. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater.; 39: No. 3, 350-3(Jun 1971). (In French).

A proposal is made for the mechanism of the self-diffusion in Pu fcc theta phase by activated interstitials (promotion of f electrons) analogous to that recommended for Pu cubic center ϵ. The deductions were based on elongation measurements made at 4°K on theta Pu or the α self-irradiation of samples inducing their contraction. (P.C.H.)

38953 INDUCING A CRITICAL STRAIN FOR GRAIN GROWTH IN A DUPLEX ZIRCONIUM ALLOY. Coleman, C. E.; Rumball, W. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 39: No. 3, 345-7(Jun 1971).

Studies were made to show that the structural condition of the duplex alloy Zr−1.25 wt% Cr−0.1 wt% Fe determines the extent of preferential grain growth during post-deformation annealing. Two groups of specimens were used. In one group the β-quenched structure was removed by heavy cold rolling and α annealing; this treatment produced an equiaxed fine grained α structure containing $ZrCr_2$ precipitates with a mean diameter of 825 Å, the distribution having a standard deviation of 475 Å. In the second group cold work between quenching and aging was omitted, and a structure with many sub-boundaries and dislocation networks as well as intermetallic precipitates with a mean diameter of 750 Å and a standard deviation of the distribution of 250 Å was found. Specimens were then cold rolled in various amounts up to 45% reduction in thickness and annealed at 760°C for 2 h. The first group of specimens obtained a maximum grain size of 15 µm after about 7% deformation. The second group deformed less than 10%, the material was not fully recrystallized, and the Widmanstatten plate width was used as the grain size, while after greater than 20% deformation an equiaxed α-grain structure was formed. Thus, a critical strain for grain growth can be induced in this alloy depending on its structure. (P.C.H.)

38954 MELTING CURVE OF MOLYBDENUM UP TO 90 KBAR. Fateeva, N. S.; Vereshchagin, L. F. (Inst. of High-Pressure Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 4, 153-4(20 Aug 1971).

$_{25}$Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 4, 233-5(20 Aug 1971).

Results of experiments to measure the melting curve of Mo by an optical method are presented. Data obtained in the experiments can be represented by the linear equation $T = 2883 \mp 0.8 \times 10^{-3} P$ where T is the melting temperature in °K and P is the pressure in bars. The data are also presented graphically. (J.R.D.)

38955 INFLUENCE OF PHASE COMPOSITION ON THERMOMECHANICAL STRENGTHENING OF ($\alpha + \beta$) TITANIUM ALLOYS. Brun, M. Ya. Tsvetn. Metal.; No. 12, 53-6(Dec 1971). (In Russian).

The mechanical properties of a number of industrial Ti alloys, and some binary Ti alloys containing from 3 to 6.5% Mo, were studied after various kinds of treatment. The phase composition and structure using optical and electron microscopes are described. (K.S.W.)

38956 STUDY OF THE α TO β TRANSFORMATION IN BORON. Runow, P. (Univ., Cologne). J. Mater. Sci.; 7: No. 5, 499-511 (May 1972).

The transformation of α-rhombohedral to β-rhombohedral boron was studied on a heating stage in an electron microscope. It was possible to freeze in three metastable phases. The orientation relationships of parent and product phases were revealed by electron diffraction. Models were developed to explain the different transformation steps. The end product of the transformation showed the lattice spacings of perfect β-rhombohedral boron, but it was deduced that the unit cell of the transformed material had a deficiency of 9 atoms compared with the 105-atom cell of perfect β-rhombohedral boron. (auth)

38957 CORRELATIONS BETWEEN PROPERTIES OF A COPPER ALLOY IN THE SYSTEM Cu–Cr–Nb AFTER DIFFERENT HEAT TREATMENTS. Novik, F. S.; Nikolaev, A. K.; Rozenberg, V. M. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 125-7 (1971). (In Russian).

Possible correlations between the electric conductivity, Vickers hardness, stability, yield, and the relative elongation were investigated for a Cu alloy in the Cu–Cr–Nb system after 18 hardening-annealing cycles. The ten pairs of properties were characterized by pair correlation coefficients with six negative values and four positive values, and ranged from –0.92 (relative elongation vs yield) to +0.96 (yield vs stability). (K.S.W.)

38958 AUGER/LEED INVESTIGATION OF THE DEPOSITION OF Al ONTO THE Mo (110) SURFACE. Jackson, A. G.; Hooker, M. P. (Systems Research Labs., Inc., Dayton, Ohio). Surface Sci.; 28: No. 2, 373-94(Dec 1971).

Six different structures and one amorphous phase are formed by Al on the Mo(110) surface. Three of the six structures are of two orientations along the Mo$[\bar{1},1]$, [2,1] and [1,1], $[\bar{2},1]$ directions giving LEED patterns rotated ±35°16′ from the [o,k] direction. The Al/Mo mismatch causes the growth of a stressed Al (111) surface as evidenced by a streaked LEED pattern, but an ideal Al(111) surface can be achieved with a thick deposition. The diffuse phase of Al coverage forms only from the ideal Al (111) structure. The c(2×2) structure forms from every initial structure upon heating to a high temperature (except for the 1-3 min depositions) and gives way to the low-coverage Al structure at a higher temperature. CO contamination from pressure $>10^{-8}$ torr during Al deposition inhibits formation of Al structures during short (1–3 min) depositions. (auth)

38959 ADSORPTION OF METHANE BY TUNGSTEN (100). Yates, John T. Jr.; Madey, Theodore E. (National Bureau of Standards, Washington, D. C.). Surface Sci.; 28: No. 2, 437-59 (Dec 1971).

Adsorption of methane by the (100) plane of tungsten was studied using flash desorption and work function methods. It was found that CH_4 adsorbs to appreciable coverage as an undissociated molecular species at ~110°K. The activation energy for first-order desorption from this state is 6.9 kcal/mole (0.30 eV/molecule). This observed binding energy is greater than expected for dispersion forces alone, and added contributions to the binding energy are discussed. An observed work function change of –0.34 eV on adsorption of CH_4 is consistent with the presence of a physically adsorbed CH_4 layer. Related studies of CH_4 adsorbed on a tungsten field-emission tip demonstrate that adsorption of CH_4 proceeds rapidly at 77°K, but is negligible at 300°K. At tungsten temperatures above 1200°K in 10^{-5} torr of CH_4, decomposition of the CH_4 to form a carbon layer occurs. It is postulated that at elevated temperatures and at high CH_4 pressures, the physically adsorbed state may be sufficiently populated to serve as a source of adsorbed CH_4 species which undergo activated surface decomposition, leading eventually to surface carbides. (auth)

38960 KINETIC ISOTOPE EFFECT IN HYDROGEN ADSORPTION ON TUNGSTEN. Gasser, R. P. H.; Morton, T. N.; Overton, J. M.; Szczepura, A. K. (Oxford Univ.). Surface Sci.; 28: No. 2, 574-80(Dec 1971).

A kinetic isotope effect in the rate of adsorption of hydrogen on polycrystalline tungsten was sought. following the report of such an effect on a (100)-oriented tungsten crystal. However, no difference between the isotopes could be detected. The reason for these discordant results may lie either in an unidentified experimental artefact or in a genuine difference between oriented and polycrystalline surfaces. (auth)

38961 RHEED STUDY OF THE ADSORPTION OF OXYGEN, HYDROGEN, NITROGEN, AND WATER VAPOR ON THE (100) FACE OF TANTALUM. Hopkins, B. J.; Leggett, M.; Watts, G. D. (Queen's Univ., Ont.). Surface Sci.; 28: No. 2, 581-97 (Dec 1971).

Reflection high-energy electron diffraction was used to study the cleaning and controlled contamination of a (100) face of a tantalum single crystal. Some impurities in the tantalum, probably oxygen and carbon, were persistent during the cleaning but could be removed by heat treatment. Hydrogen and oxygen exposure at room temperature gave rise to amorphous films though annealing of the oxygen overlayer formed two ordered structures. Water vapor behaved rather like oxygen; nitrogen, however, gave immediate new diffraction beams at room temperature. (auth)

38962 AUGER SPECTROSCOPY STUDY OF THE ADSORPTION OF Rb ON Mo (110). Thomas, S.; Haas, T. W. (Aerospace Research Labs., Wright Patterson AFB, Ohio). Surface Sci.; 28: No. 2, 632-6(Dec 1971).

Auger electron spectroscopic observations were made on the adsorption of 6-eV Rb ions on the Mo(110) surface at room temperature, using a 1.5-keV primary beam. The Rb and Mo peaks were monitored as functions of Rb coverage. Above the ion density of 13×10^{14} ions/cm^2, there is no change in the peak heights. (D.L.C.)

38963 AGING CHARACTERISTICS OF Ti–Mo BASE BETA ALLOYS. Ohtani, Shitoshi; Nishigaki, Minoru (Kobe Steel, Ltd., Japan). J. Jap. Inst. Metals; 36: No. 4, 346-51(Apr 1972). (In Japanese).

Studies were made to obtain a detailed knowledge of aging properties of Ti–Mo-base beta alloys. The effects of solution-treatment, normal aging, two-step aging, and isothermal transformation on the tensile properties, in connection with the microstructures of three beta alloys were investigated. Though aluminum suppressed precipitation of the omega phase, the embrittlement due to the alpha phase which was hardened by aluminum was remarkable in the Al-bearing alloy, Ti–12 Mo–5 Zr–3 Al, in which the alpha phase precipitated in abundance. Ti–15 Mo–5 Zr–3 Al showed a high strength of 143 kg/mm^2 even after aging at a rather high temperature, 550°C, because aluminum strengthened the alpha phase. The optimum aging temperature range for the Al-free alloy, Ti–15 Mo–5 Zr, was narrow, in which balanced tensile properties with an ultimate tensile strength of 140 kg/mm^2 and an elongation of 11% were obtained. The alpha which precipitated primarily at grain boundaries after isothermal transformation was not effective for strengthening. There was no fundamental differences between normal and two-step aging in this study. The fact that the precipitation site of the alpha phase during aging was affected by the preceding solution treatment was attributed to the recrystallization of beta grains. The Ti–15 Mo–5 Zr solution-treated at the temperature just below the beta-transus, consisted of the recrystallized and non-recrystallized grains, and the alpha phase which was not hardened by aluminum precipitated preferentially on dislocations in the latter grains. In the alloy solution-treated at a temperature considerably higher the beta transus, the alpha phase precipitated at grain boundaries. Ductility of the former alloy was much higher than that of the latter. (auth)

38964 PRECIPITATION PROCESSES OF Cu–Zr–Cr ALLOYS. Suzuki, Hisashi; Kanno, Motohiro (Tokyo Univ.). J. Jap. Inst. Metals; 36: No. 4, 363-8(Apr 1972). (In Japanese).

Precipitation processes of a Cu–Zr–Cr ternary alloy have been investigated by means of specific heat and electric resistance measurements, comparing with those of Cu–Zr and Cu–Cr binary alloys. Specimens were solution-treated at 950°C and quenched into iced water. Subsequently they were aged or cold-rolled about 83% and then aged under various conditions. The precipitation processes during aging at temperatures elevated at a constant rate of 2°C/min were examined in detail. The results showed that in the as-quenched specimen, Cr precipitate appeared first at about 440°C and then Cu_3Zr precipitate occurred separately at about 520°C. The former temperature was about 15°C higher than that of Cu–Cr alloy. In the worked specimen, the order of precipitation was reversed, that is, Cu_3Zr and Cr appeared at about 370 and 425°C, respectively. The two sorts of precipitation temperature observed in each case of the ternary alloy agreed well with that of each binary alloy, with the exception of the above-mentioned temperature of Cr precipitates. It was found that the above results could satisfactorily be explained by the precipitation diagram (the T-T-T diagram) of the ternary alloy which was established qualitatively as consisting of four curves (two curves corresponding to homogeneous and heterogeneous precipitations of Cr and the other two curves of Cu_3Zr). The property changes during isothermal aging could also be accounted for by using this diagram. (auth)

38965 STUDY OF STRUCTURE TRANSFORMATIONS IN Zr–Nb ALLOYS. PART 1. Guerillon, J. P. Metaux (Corros.-Ind.); 46: No. 556, 446-63(Dec 1971). (In French).

In certain CO_2 cooled nuclear reactors, Zr–Nb alloys are used to clad the fuel elements or as pile materials. Bibliographic data relating to the Zr–Nb equilibrium diagram, the experimental techniques developed to prepare these alloys, and for Nb determination (colorimetry) are presented. The decomposition mechanisms involved in the quenching under vacuum of the continuous solid solution formed at high temperatures between Zr and Nb were studied. The direct quenching of alloys after annealing at a temperature in the single phase region β(1000°C) was studied. A transformation of the β solid solution into an α' solid solution occurred. The discontinuous quenching of dilute alloys, alloys containing 10 to 30% Nb, and a 49% Nb alloy after annealing at 750°C was investigated. France)

38966 LATTICE DYNAMICS, THIRD ORDER ELASTIC CONSTANTS, AND LOW TEMPERATURE LATTICE THERMAL EXPANSION OF ZIRCONIUM. Menon, C. S.; Rao, R. Ramji (Indian Inst. of Tech., Madras). J. Phys. Chem. Solids; 33: No. 6, 1325-34(Jun 1972).

The lattice dynamics and the anharmonic properties of hexagonal Zr were determined using Keating's approach (Phys. Rev. 145: 637 (1966) and 149: 674 (1966)). The dispersion curves were fitted using twelve second-order parameters and the six second-order elastic constants were evaluated. The ten third-order elastic constants were calculated using five third-order parameters. The experimental measurements on the pressure derivatives of the second-order elastic constants were in good agreement with the calculated values. The low-temperature limit of the lattice thermal expansion was calculated and agreed well with the value obtained from thermal expansion data. The variation of the generalized GPs of the elastic modes with the direction of propagation is illustrated by polar diagram. (auth)

38967 DIFFUSION COEFFICIENT OF IRON IN α-URANIUM AT 645°C. Stelly, M.; Servant, J. M. (CEN de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater.; 43: No. 3, 269-72 (Jun 1972). (In French).

The diffusion coefficient of iron in α-uranium at 645°C measured by Buckle's method was 3×10^{-10} cm^2/s. This value was close to that obtained for cobalt and more than 10^3 times larger than the self-diffusion coefficient at the same temperature. The diffusion was anisotropic and a preferential diffusion existed along the grain boundaries. (auth)

38968 SUPERCONDUCTING TRANSITION BEHAVIOR OF Zr–Nb BINARY ALLOYS. Narasimhan, S. L.; Taggart, R.; Polonis, D. H. (Univ. of Washington, Seattle). J. Nucl. Mater.; 43: No. 3, 258-68(Jun 1972).

The superconducting transition behavior of Zr–Nb binary alloys has been investigated in conjunction with studies of the alloy constitution and microstructure. The superconducting transition temperature (T_c) is reduced by the formation of the omega phase during aging and is raised by a subsequent omega reversion treatment. Isothermal aging at 550°C for 175 h increased the value of T_c from 6.82°K in the as-quenched condition to 10.2°K. The temperature range characterizing the superconducting transition was broadened by the presence of composition fluctuations in the beta phase. The formation of the aged omega phase at 350°C was inhibited by repeated aging and reversion treatments. (auth)

38969 CONTRIBUTION TO THE STUDY OF THE SYSTEM U–Pu–W–C. Ugajin, M.; Suzuki, Y.; Shimokawa, J. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 43: No. 3, 277-92(Jun 1972).

M–W–C alloys (M = U and/or Pu) were investigated with the methods of x-ray diffraction and metallography. A new compound $PuWC_2$ was found; its structure is UWC_2-type orthorhombic with lattice parameters a = 5.621 ± 0.003 Å, b = 3.245 ± 0.002 Å, c = 10.877 ± 0.007 Å. Phase relations in the Pu–W–C system were also studied and the constitutional diagram at 1400°C is proposed. The occurrence of the orthorhombic $PuWC_2$–UWC_2 solid solutions, (U, Pu)WC_2, has been confirmed in the entire range of composition. Alloys of compositions $UWC_{1.64-2.20}$ were examined to determine the phase boundaries at 1700°C. The results showed that the orthorhombic phase has a narrow stoichiometry range with approximate limits of $0.00 \leq x \leq 0.10$ in UWC_{2-x}; the cell size slightly decreases with carbon dissolution in the defect lattice. The existence of the $UMoC_{1.70}$-type monoclinic $UWC_{1.75}$, previously denoted η-UWC_2, has been established, with lattice parameters a = 5.6248 ± 0.0012 Å, b = 3.2433 ± 0.0008 Å, c = 11.650 ± 0.002 Å, β = 109.60 ± 0.01°. X-ray diffraction powder data are presented for $PuWC_2$, UWC_2, and $UWC_{1.75}$. (auth)

38970 DIFFUSION COEFFICIENT OF HYDROGEN IN ALPHA ZIRCONIUM, ZIRCALOY-2, AND ZIRCALOY-4. Kearns, J. J. (Bettis Atomic Power Lab., Pittsburgh). J. Nucl. Mater.; 43: No. 3, 330-8(Jun 1972).

The diffusion coefficient of hydrogen in zirconium, Zircaloy-2, and Zircaloy-4 was determined in the temperature range, 275 to 700°C. No measurable differences were found among the coefficients for the three materials, nor was there observed any effect of grain size or cold work. However, small differences were found depending on sample orientation in rolled sheet. Values of the Arrhenius constants, D_0 and Q, for the longitudinal, transverse and through-thickness directions were, respectively, 7.73×10^{-3} cm^2/sec and 10,830 cal/mole, 5.84×10^{-3} cm^2/sec and 10,290 cal/mole, and 7.90×10^{-3} cm^2/sec and 10,730 cal/mole. These results, combined with an analysis of the crystallographic texture in the sheet, indicate that the ratio of the single crystal diffusion coefficients parallel and perpendicular to the "c" axis of the hexagonal structure, $D_{||}/D_{\perp}$, is greater than one, but probably not more than two. (auth)

38971 SELECTING PLATE STEELS FOR NUCLEAR STEAM SUPPLY SYSTEMS. Sterne, Robert H. Jr.; Gorman, William H. Jr.; Brooks, Robert L. (Lukens Steel Co., Coatesville, Pa.). Metal Progr.; 101: No. 3, 71-2; 74-7(Mar 1972).

Applications of plate steels in steam supply systems for pressurized water reactors, boiling water reactors, high-temperature gas-cooled reactors, and heavy-water moderated reactors are reviewed. Discussions and data are included on ASTM Types A36, A387, A442, A516, A517, A533, A542, A543, and A588. (J.R.D.)

38972 MEASUREMENT OF THE SPECIFIC SURFACE OF NONSPHERICAL METAL POWDERS BY THE METHOD OF THERMAL NITROGEN DESORPTION. Darievich, Yu. S.; Pugin, V. S. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 12, 943-5(Dec 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 12, 4-7(Dec 1971).

An apparatus was developed enabling the specific surface of powders and porous solids to be measured by the thermal nitrogen desorption (MTD) method. It was found that the method may be employed for determining the properties of metal powders and studying powder metallurgy processes. (auth)

38973 EFFECT OF HEAT TREATMENT ON THE PROPERTIES OF SINTERED NICKEL–MOLYBDENUM AND NICKEL–CHROMIUM–MOLYBDENUM ALLOYS. Solonin, S. M.; Chernyshev, L. I.; Fedorchenko, I. M. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 12, 974-7(Dec 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 12, 44-8(Dec 1971).

Tempering at 750 to 800°C severely embrittled the sintered Ni–30% Mo alloy and reduced its corrosion resistance. By employing the method of electrical resistivity measurement, it is possible rapidly to assess the structural state of the alloy and the extent of its losses of corrosion resistance and ductility. To ensure high properties in sintered parts made of the Ni–30% Mo alloy, cooling must be performed rapidly in the range from the sintering temperature to 500°C. The deterioration in properties after tempering was less marked for the sintered Ni–15% Cr–15% Mo alloy than for the corresponding cast alloy of commercial purity. The reason for this appears to be that, because of its lower impurity content, the sintered alloy was less susceptible to σ phase precipitation. (auth)

38974 STUDY OF NIOBIUM DIFFUSION INTO COPPER BY AN ELECTRICAL-RESISTANCE METHOD. Borukhin, L. M.; Shpichinetskii, E. S. Ind. Lab. (USSR) (Engl. Transl.); 37: No. 10, 1530-2(Oct 1971).

Translated from Zavod. Lab.; 37: No. 10, 1196-8(Oct 1971).

The diffusion of Nb into Cu was studied by an electric conductivity method for bimetallic wire samples, 0.12 mm in diameter, for which an infinitely-long-cylinder model with constant concentration of the diffusing element on the surface was assumed. The diffusion parameters were calculated to be D_0 = 4.91 ± 0.22 cm^2/sec, Q = 52.6 ± 10.3 kcal/mole. (P.C.H.)

38975 VOLUME CONTRACTION DURING MELTING: EMPHASIS ON LANTHANIDE AND ACTINIDE METALS. Wittenberg, Layton; DeWitt, Robert (Mound Lab., Miamisburg, Ohio). J. Chem. Phys.; 56: No. 9, 4526-33(1 May 1972).

A review of the volume change during melting indicates that the majority of metals exhibits an average volume increase of 3.8% during this phase transformation. The volume increase is unusually small for La, Pr, Nd, and Np, and is negative for the semimetals plus cerium and plutonium. Based on a free-volume relationship for viscous flow, a close-packed structure for the liquid (V_l^0) was calculated which was nearly the same as the volume of the solid (V_s) at the melting point for a number of close-packed metals, the rare gas solids Ar, Kr, and Xe, the alkali metals, Hg, and the lanthanide metals La and Yb. The value of V_l^0 was significantly less than V_s for Bi, Ga, Ce, Pr, U, and Pu. Examination of the phase diagrams of Bi, Ga, and Pu revealed that V_l^0 corresponded to the volume of the phase formed under pressure at which point the slope of the melting curve became zero. The mechanisms postulated for the formation of V_l^0 smaller than V_s were closer-packing for the semimetals and slight valence increases with corresponding reductions in metallic radii for Ce, Pr, U, and Pu. Additionally, the use of liquid compressibility values correctly predicted the pressures at which the slopes of the melting curves became zero. The Lindemann melting law and extensions derived from it were found to be invalid for all metals which contract during melting. (auth)

38976 SHOCK AND ROLLING TESTS ON Fe–Co–V ALLOY. FURTHER RECOVERY BEHAVIOUR. Desoyer, J. C.; Eymery, J. P.; Moine, P. (Faculte des Sciences, Poitiers, France). Acta Met.; 20: No. 7, 959-68(Jul 1972). (In French).

260 kb pressure shock tests on disordered or ordered polycrystalline Fe−Co−V specimens were carried out. In disordered alloys (bcc), the shock resulted in classical (112) twins and work hardening dislocations were distributed nearly uniformly. In ordered alloys, the shock created antiphase boundaries and partially destroyed long range order; some very thin twins could be observed, but their type is not yet determined; no cellular structure appeared. Comparisons with rolled specimens were made; the alloy was not disordered by rolling, dislocations were uniformly distributed in disordered specimens, and a cellular structure appeared in slightly strained ordered specimens. The effect of ordered recovery was investigated in specimens first disordered and then work hardened by shock or rolling. In both conditions, it appeared that the hardness and the size of antiphase boundaries increased while a polygonized structure appeared; the more important was the hardness increase, the higher was the initial work hardening rate. On the contrary, in specimens ordered then shocked, a recovery resulted in a decrease of hardness and an increase of antiphase boundary size. (auth)

38977 SUPERPLASTICITY IN LARGE GRAINED MATERIALS. Griffiths, P.; Hammond, C. (Univ. of Leeds, Eng.). Acta Met.; 20: No. 7, 935-45(Jul 1972).

The high-temperature deformation properties of the bcc phases of three titanium alloys, copper−zinc and copper−aluminum alloys were determined. Superplastic behavior was found in all except the copper−aluminum alloy without the usual pre-requisite of a fine grain size. The mechanical properties and related microstructures of these alloys are described and the significance of these results in the general interpretation of superplasticity is discussed. (auth)

38978 LAMELLAR EUTECTOID GROWTH. Carpay, F. M. A. (Philips Research Labs., Eindhoven, Netherlands). Acta Met.; 20: No. 7, 929-34(Jul 1972).

A stepwise growth model is proposed for the growth of lamellae during eutectoid decompositions. The basic features of this model are the initial nucleation of disks followed by outgrowth of the nuclei over the lamellar surface. It is argued that the outgrowth of the nuclei is the rate determining parameter. The resulting relationships are compared with experimental data for the eutectoid systems β Cu−In, β Ni−In and Co_3Si. The model provides an explanation for the strong dependence of the maximum possible pulling rate, that gives rise to parallel lamellae, on the temperature of decomposition. A similar dependence is experimentally found in the constant from the $\lambda^4 R$ = constant relationship, which can be explained in the same way. A consequence of the model is that a fundamental minimum value for the interlamellar period in the case of aligned eutectoid decomposition is found. This λ_{crit} is estimated to be of the order of magnitude of 0.1 μm. (auth)

38979 ORIENTATION DEPENDENCE OF SLIP IN TANTALUM SINGLE CRYSTALS. Takeuchi, S.; Kuramoto, E.; Suzuki, T. (Tokyo Univ.). Acta Met.; 20: No. 7, 909-15(Jul 1972).

Zone-reflected and annealed tantalum single crystals were deformed at temperatures between 4.2 and 450°K to investigate the deformation mechanism at low temperatures. Three types of axial orientations, [149], near [011] and near [001], were chosen so that the maximum shear stress was applied on either of {110}, twinning {112} and anti-twinning {112} planes. No twinning deformation was observed in any orientations even at liquid helium temperature. The orientation dependences of the yield stress and slip patterns showed a characteristic anisotropy and results were explained most naturally on the assumption that the activated slip planes were {110} and twinning {112}. By assuming that the screw dislocation under no stress has two types of spreading core configurations with an equivalent energy, changeable to each other, the slip behaviors can be interpreted by the successive process of overcoming the Peierls potential hills, in which the core configuration of glide dislocations is transformable from one to another depending on the direction of the applied stress. It is concluded that the normal stress on the slip plane has an effect on the Peierls potential from the comparison of yield stresses for tension and compression with each other. (auth)

38980 ROLE OF OXYGEN AND NITROGEN IN THE RECOVERY PROCESS OF NIOBIUM. Eto, Motokuni (Tokyo Univ.). J. Mater. Sci.; 7: No. 5, 567-76(May 1972).

Electrical resistivity and Vickers hardness were measured in order to clarify the role of oxygen and nitrogen atoms in the Stage III recovery of niobium. Defects were introduced mainly by means of cold-rolling. Specimens were prepared from the material. A(O + N < 50 ppM), B(O + N ≃ 210 ppM) or C(O + N ≃ 850 ppM). All specimens showed recovery in the temperature range 100 to 200°C; an additional recovery stage was observed in the material C and nitrogen-doped B. The values of activation energy for A and B were 0.7 eV. The order of reaction was second for A, while it was first for B. For C, activation energy and the reaction order were 1.2 eV and first, respectively. For the additional stage of C, the value of 3.4 eV was obtained, but the reaction was not simple. From these and other results concerning the change in hardness, irradiation and quenching experiments, the dominant mechanism for recovery was considered. It is believed that point defects, probably the interstitial atoms, played a very important role in the recovery process of A and B, while in C recovery seemed to be due to migration of oxygen atoms. (auth)

Radiation Effects

Refer also to abstracts 40087, 40089, 40224, and 40433.

38981 (AERE-R–6822) CREEP MEASUREMENT OF IRRADIATED SPECIMENS BY NEUTRON RADIOGRAPHY. Matfield, R. S. (Atomic Energy Research Establishment, Harwell (England)). Apr 1972. 24p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The creep of irradiated specimens was measured by a "marker" technique whereby the change in specimen size is followed by a pair of plungers which are "marked" by thin washers of dysprosium. This material has a large neutron cross-section, and the "marker" consequently shows on a radiograph as a fine high-contrast line. The distance between two such lines is directly related to the size of the specimen, and by comparing this with the distance between two other fixed "markers" of known separation (also within the experiment) separation of the moving "markers" can be gauged precisely. This method measures the growth of the specimen to ± 0.001 inches. (auth)

38982 (CEA-N–1517) QUINQUENNIAL PROGRESS REPORT, 1966–1970. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1972. 67p. (In French). Dep. NTIS (U. S. Sales Only).

The main results obtained during the 1966 to 1970 period are presented. The interaction of channeled particles with crystalline defects is studied; theoretical evaluations are compared with experimental results (boundaries, stacking faults, dislocations. . .). The effects of channeling on particle range were measured. Different facilities, especially for low temperature, were constructed. The most original of these are described. Natural growth phenomena were also studied (in detail for the case of U). The concept of growth is extended to the case of cubic metals irradiated under stress (induced growth). Some properties of defects (quenched vacancies, martensitic transformation defects, clusters of radiation defects) are described. The results obtained in the study of the amorphous state (formation conditions and properties) and tracks in insulating solids (formation conditions and applications) are presented. (70 references) (France)

38983 (CEA-R–4315) GROWTH OF α URANIUM BY IRRADIATION AT LOW TEMPERATURES. Weinberg, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1972. 127p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France). Faculte des Sciences.

Growth of α uranium evolves as a dimensional change under neutron irradiation, i.e., the length increases in the [010] direction and decreases along [100] without significant change in volume. Results of measurements of length and resistivity variations along the axis of polycrystalline wires ([010] texture) under irradiation at low temperatures show that the growth is proportional to the burnup only at high doses ($\tau > 6 \times 10^{-7}$). The length and resistivity changes depend on the concentration of defects, on their formation volume, and on their electrical resistivity. At low burnups ($0 < \tau < 5 \times 10^{-8}$) the length variations vs τ (negative curvature) are due to point defects (isotropic volume increase). At high burnups growth is due to the condensation of the interstitials created per fission in dislocation loops of Burgers vectors $\frac{1}{2} \langle 110 \rangle$ and of vacancies in dislocation loops of Burgers vectors [100] (BUCKLEY mechanism). To explain the growth in the whole range of burnups a model is proposed which includes defect production rate and the creation and growth of the dislocation loops. By adjusting some parameters (formation volumes and electrical resistivity), calculated variations of length and resistivity versus burnup are obtained in good agreement with the experimental results. The results also confirm the decrease of growth rate when irradiation temperature is increased and the influence of preexisting dislocations on growth. (auth)

38984 (CONF-720604-4) EFFECT OF IRRADIATION OF THE MICROSTRUCTURE AND CREEP-RUPTURE PROPERTIES OF TYPE 316 STAINLESS STEEL. Bloom, E. E.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). 1972. 41p. Dep. NTIS.

From Symposium on the effects of radiation on structural materials; Los Angeles, CA. (26 Jun 1972).

The effects of irradiation to fluences in the range 1.2 to 2.7 × 10^{22} neutrons/cm^2 (>0.1 MeV) on the microstructure and creep-rupture properties of annealed and cold-worked Type 316 stainless steel were examined for irradiation temperatures in the range 450 to 825°C. For irradiation in the annealed condition below about 650°C, voids and dislocations were formed. Cold working before irradiation suppressed void formation at all temperatures except 580°C where voids were occasionally found in recovered areas. Extensive precipitation occurred at temperatures above about 500°C, and the amount and type of precipitate was sensitive to the initial microstructure. Changes in rupture life and creep rate were observed, but the most significant effect of irradiation was a large decrease in ductility resulting from enhanced intergranular fracture. The grain boundary cracks were formed by the linking of cavities on those boundaries nearly normal to the applied stress. The experimental results are most consistent with a model in which nucleation of the cavities occurs on helium bubbles with growth controlled by stress enhanced diffusion of vacancies. Experimental evidence also indicates that the strength of the matrix influences the crack propagation rate. (auth)

38985 (HEDL-SA-300) POSTIRRADIATION CREEP OF ANNEALED TYPE 316 STAINLESS STEEL. Lovell, A. J. (Hanford Engineering Development Lab., Richland, Wash.). Apr 1972. Contract AT(45-1)-2170. 29p. Dep. NTIS.

The effects of fast reactor irradiation on the creep behavior of annealed Type 316 stainless steel were reviewed, and the interrelation between creep response and radioinduced microstructure development is discussed. The effects of neutron fluence, irradiation temperature, and test temperature on creep response are described using illustrative examples. The results indicated that use of creep data from unirradiated specimens for design purposes over estimates strain expected during irradiation, except when a component is stressed at low temperature following high-temperature irradiation. (auth)

38986 (HEDL-SA-317) MATERIALS PERFORMANCE PREDICTION FROM IRRADIATION TEST DATA. Yoshikawa, H. H. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1972. Contract AT(45-1)-2170. 24p. (CONF-720604-3). Dep. NTIS.

From Symposium on the effects of radiation on structural materials; Los Angeles, CA. (26 Jun 1972).

A method of determining irradiation effectiveness of different neutron spectra in causing radiation damage to fuel cladding and reactor structural materials is described. It involves the definition of a semi-empirical damage function or cross section using measured data from specimens irradiated in thermal and fast test reactor spectra. The damage function is applied to design problems involving irradiation effects to reactor structural and fuel cladding materials to predict the fluence which would produce a specific damage level. (auth)

38987 (IS-2833) EFFECT OF NEUTRON IRRADIATION ON VANADIUM. McIlwain, J. F.; Chen, C. W.; Bajaj, R.; Wechsler, M. S. (Ames Lab., Iowa. Iowa State Univ. of Science and Technology, Ames (USA). Dept. of Metallurgy). Mar 1972. 21p. (CONF-720604-2). Dep. NTIS.

From Symposium on the effects of radiation on structural materials; Los Angeles, CA. (26 Jun 1972).

The effect of neutron irradiation on vanadium containing 50 to 800 wt ppM oxygen was studied using electrical resistivity, internal friction, and mechanical property measurements. The resistivity and internal friction specimens were irradiated to 3×10^{18} neutrons/cm^2 (E > 1 MeV) at −190°C and the tension test specimens were irradiated to 1.2×10^{19} neutrons/cm^2 (E > 1 MeV) at 106°C. Post-irradiation annealing treatments were performed up to 220°C for the resistivity and internal friction specimens and up to 520°C for the tension test specimens. Isochronal resistivity annealing measurements exhibited annealing stages at 170, 30, and −105°C. The highest temperature stage (near 0.2 T_m, where T_m is the melting temperature) is attributed to the motion of interstitial oxygen to radiation-produced defect clusters and loops, where the oxygen is effectively removed from solid solution. This conclusion is based on the observation that: (1) the annealing activation energy is 1.1 ± 0.1 eV, close to the oxygen migration energy of 1.23 eV; (2) the magnitude of the annealing stage increased with increasing oxygen concentration; and (3) the decreases in oxygen concentration in solid solution upon annealing deduced from the decrease in resistivity and the decrease in the oxygen internal friction peak are in substantial agreement. The origins of the two lower temperature peaks are unknown, although it is speculated that hydrogen may be involved in the peak at −105°C. The yield stress measurements indicate that radiation exposure at 106°C results in greater radiation hardening for specimens with larger oxygen concentration. Also, the further increase in strength upon post-irradiation annealing (radiation-anneal hardening) is enhanced by increasing interstitial impurity concentrations. These increases in strength are accompanied by decreases in ductility, a matter that may be of importance in the use of structural bcc metals in elevated temperature radiation environments. (auth)

38988 METALLURGICAL PROPERTIES OF IRRADIATED COLD-WORKED Zr-2.5 WT. PERCENT Nb PRESSURE TUBES. Langford, W. J.; Mooder, L. E. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 39: No. 3, 292-302 (Jun 1971).

Three cold-worked pressure tubes of Zr−2.5 wt% Nb were irradiated as components of Chalk River reactor loops, under operating conditions similar to those in the Canadian design of heavy water-cooled, heavy water-moderated power reactor. A fourth tube, part of which was artificially prehydrided to about 200 ppM H_2, was irradiated unstressed, in air. The post-irradiation examination of these tubes showed that they can tolerate severe defects; for instance the critical crack length of irradiated hydrided tubing exceeds 5 cm (2 in.) at the design stress for Pickering 3 and 4 reactors, 145 MN/m^2 (21,000 psi). Mechanical strength was increased by neutron irradiation, and both uniaxial and biaxial tests showed localized plastic deformation at failure. Oxide film thicknesses showed the beneficial effects of ammonia dosing of the water coolant, and hydrogen pickup was acceptably low. (auth)

38989 DUCTILITY OF IRRADIATED TYPE 304 STAINLESS STEEL AND ITS APPLICATION TO FUEL-ELEMENT DESIGN. Franklin, D. G. (Argonne National Lab., Idaho Falls, Idaho). J. Nucl. Mater.; 39: No. 3, 335-8(Jun 1971).

Type 304 stainless steel cladding material from fuel pins irradiated to 10^{22} n/cm^2 in the EBR-II fast flux reactor and unirradiated control material, both 0.23 mm in thickness, were tensile tested at temperatures of 400, 500, and 550°C at strain rates of 0.02 and 0.002 min^{-1}. Irradiation decreased the elongation and increased the ultimate strength. After tensile testing, the specimens were examined in the scanning electron microscope. The results revealed transgranular ductile fracture at each temperature and strain rate. It was concluded that elongation measured in a tensile test is not by itself a sufficient measure of ductility for fuel element behavior. Considerably more useful ductility may be available in some irradiated materials than is indicated by this elongation. The amount of useful ductility appeared to be related to the local reduction in area. (P.C.H.)

38990 VOIDS IN IRRADIATED METALS. Seeger, A. (Max-Planck Inst. fuer Metallforschung, Stuttgart). Comments Solid State Phys.; 4: No 3, 79-84(Mar-Apr 1972).

After a brief historical introduction more recent theoretical concepts and practical implications and studies are reviewed. It is pointed out that the temperature range in which voids are formed is that at which the next generation of fast reactors is planned to operate, and in view of the high irradiation doses involved the importance of the findings is easily realized. In addition to reactor irradiation studies, high voltage electron microscope studies are discussed; these studies have proved of considerable value in shaping and testing theoretical views on void formation in irradiated metals. The formation of voids during electron bombardment in high voltage electron microscopes demonstrates that the production of vacancies in clusters, as during fast neutron bombardment, is not a prerequisite for void formation. Bombardment with heavy ions is also considered. (20 references) (UK)

38991 VOIDS IN IRRADIATED METALS. PART I. Norris, D. I. R. (Berkeley Nuclear Labs., Eng.). Radiat. Eff.; 14: No. 1-2, 1-37(May 1972).

Any type of irradiation that displaces atoms can produce voids in non-fissile metals and alloys, consequent swelling and mechanical property effects becoming important in fast reactor design and operation. The basic reason for void formation is preferential absorption of interstitials at dislocations. Void growth depends on competition between alternative sinks for diffusing vacancies and interstitials. Irradiation and materials variables affect void formation through both the point defect behavior and the dislocation behavior. Void ordering and annealing effects are also discussed. (auth)

38992 SWELLING RESISTANCE OF A HIGH NICKEL ALLOY. Appleby, W. K.; Sandusky, D. W.; Wolf, U. E. (General Electric Co., Sunnyvale, Calif.). J. Nucl. Mater.; 43: No. 3, 213-18(Jun 1972).

Results from the side-by-side irradiation of three high nickel alloys in a fast flux reactor (EBR-II) indicated that void formation and the resultant swelling in these materials are governed by alloy microstructure. Immersion density measurements showed appreciable swelling in Incoloy 800 and Hastelloy X but a densification in Inconel 625 after irradiation to 5×10^{22} n/cm^2, E > 0.1 MeV. Transmission electron microscopy revealed that Inconel-625 containing closely spaced Ni_3Nb precipitate particles developed no voids, whereas Incoloy-800 and Hastelloy-X with markedly different microstructures each showed extensive and distinctive void formation. (auth)

38993 INFLUENCE OF IMPURITY CONTENT ON THE RADIATION SENSITIVITY OF PRESSURE VESSEL STEELS: USE OF ELECTRON MICROPROBE FOR IRREGULAR SURFACES. Ohmae, K.; Ziebold, T. O. (Massachusetts Inst. of Tech., Cambridge). J. Nucl. Mater.; 43: No. 3, 245-57(Jun 1972).

A basic study of the radiation sensitivity of common residual impurity elements in pressure vessel steel, A302-B, was conducted. It was found that a carefully controlled heat of "laboratory-pure" A302-B is insensitive to neutron irradiation in terms of the 30 ft-lb transition temperature of the Charpy-V notch impact test when irradiated at a typical reactor-operating temperature of 300°C. Addition of 0.02 wt% sulfur to this heat did not change the transition temperature after irradiation, but reduced the upper-shelf energy corresponding to the high-temperature ductile fracture. This was explained in terms of the manganese-iron sulfide inclusions removing the added sulfur from the matrix, thereby keeping the matrix essentially free of sulfur. Further addition of 0.03 wt% phosphorus to this heat caused an upward shift of the transition temperature after irradiation by 45°C (80°F). Electron-probe work on this specimen elucidated that phosphorus is microscopically uniformly dissolved in the matrix and it was postulated that the radioinduced defects interact with this uniform phosphorus, forming stable defect-impurity clusters at 300°C. (auth)

38994 THERMODYNAMICS OF GAS-CONTAINING VOIDS IN METALS. Russell, K. C. (Massachusetts Inst. of Tech., Cambridge). Acta Met.; 20: No. 7, 899-907(Jul 1972).

Irradiation of materials frequently induces high supersaturations of vacancies and of dissolved inert gas atoms which may, under certain conditions, co-precipitate into voids. An expression is derived for the free energy change on forming such a void and is expressed in terms of vacancy supersaturations, the concentration and binding energy of the dissolved gas atoms, external pressure, strain energy, and such ancillary data as surface energy and atomic volume. This free energy may be utilized to obtain boundary conditions for void growth and dissolution problems. An expression is derived for the homogeneous nucleation rate of voids, from which it is seen that externally applied pressures should usually have little effect on void formation. Dissolved gas atoms may, however, contribute as much to the driving force for nucleation as does a very high vacancy supersaturation. It is noted that in omitting the effects of solvent interstitials, the analysis is not directly applicable to fast-breeder reactor phenomena. (auth)

38995 CONTINUUM MECHANICS AND MICROMECHANISMS FOR IN-REACTOR CREEP OF ZIRCONIUM ALLOYS. Holicky, Milan. Waterloo, Ont.; Univ. of Waterloo (1971).

Thesis.

Studies were made relating to the limited number of experimental data for in-reactor creep of zirconium alloys obtained at AECL, Chalk River, for design of anisotropic pressure tubes used in Canadian Deuterium Uranium power reactors. Combining a continuum mechanics analysis of creep with data available at AECL for texture and anisotropic structure of zirconium alloy grains, it was found that magnitudes of in-reactor material constants of the zirconium alloy continuum can be predicted from the limited number of experimental data, and conclusions may be drawn regarding design for diametral creep and sag of horizontal pressure tubes. Using a method of correlation of continuum mechanics and micromechanisms, it was found that the significance of various micromechanisms proposed for in-reactor creep of zirconium alloys may be predicted. Results obtained at AECL from recent in-reactor creep tests on a zirconium alloy pressure tube and in-reactor uniaxial test on both longitudinal and tangential specimen cut from this tube appeared to verify the magnitudes of the material constants proposed for the zirconium alloy continuum. (Diss. Abstr. Int., B)

38996 EFFECTS OF DIFFERENT MICROSTRUCTURES ON THE FORMATION OF DISLOCATION LOOPS IN ALUMINUM DURING ELECTRON IRRADIATION. Wolfenden, A. (Oak Ridge National Lab., Tenn.). Micron; 3: No. 1, 51-61(1971-72).

Exposure to the beam in a 200 kV electron microscope caused defect clusters to form in high-purity aluminium foils. The damage was due to the direct displacement of atoms by electrons. The point defect clusters nucleated randomly and grew to form dislocation loops. The microstructure of the aluminium was varied by quenching or alloying. In high-purity foils containing previously quenched-in Frank sessile vacancy loops the subsequent electron radioinduced defects were found to interact with the pre-existing defects. In 99% aluminium and in 2024 aluminium (4.5% Cu, 1.5% Mg, 0.6% Mn, balance Al) no electron-induced damage was found. However, when the 99% aluminium specimens were first neutron irradiated, subsequent bombardment by electrons caused the development of visible dislocation loops. The important conclusion of this electron microscope study is that the presence and distribution of electron irradiation damage in aluminium is extremely sensitive to microstructure. (auth)

38997 NATURE AND ANNEALING CHARACTERISTICS OF ION RADIATION DAMAGE IN GOLD, SILVER, AND COPPER. Rojo, J. M.; Bru, L. (Univ., Madrid). Phil. Mag.; 25: No. 6, 1409-27(Jun 1972).

Thin films of gold, silver, and copper epitaxially grown with orientation $\{100\}$ onto NaCl substrates were irradiated with Ar ions with energies up to 5 keV, the total doses being in the range of 10^{15} to 10^{17} ions cm^{-2}. The resulting damage structure, as well as its recovery behavior in the course of thermal treatments, were investigated by transmission electron microscopy. The damage is localized in a surface layer $\simeq$70 Å thick and two main components may be distinguished: one consisting of small unresolvable defects, the other consisting of clearly resolvable dislocation loops either round or elongated. Dynamical diffraction contrast analysis shows that the loops have Burgers vectors $a/2\langle 110\rangle$ parallel to the surface and are interstitial in character. The Burgers vector direction is obtained by direct comparison with the stacking-fault traces and no complicated manipulations are required. On the other hand, in the light of their annealing behaviour, it is proposed that the unresolvable defects are small three-dimensional interstitial clusters. The annealing process involves three stages. In stage A, the small clusters anneal out by emitting interstitials, a fraction of which makes loops grow. In stage B, the round loops anneal out by capturing vacancies with an activation energy slightly lower than that of self-diffusion for the corresponding metal. At the same time, constrictions appear on the elongated loops, that finally split into round loops. Self-climb is thought to be the mechanism responsible for this behavior. Finally, in stage C the loops originated by the former mechanism anneal out by self-diffusion. (auth)

Other Materials

Refer also to abstracts 38369, 38875, 38936, 40088, and 40096.

38998 (LA-DC-13292) INFLUENCE OF CREEP STRAIN ON THE ELASTIC MODULUS, CRYSTALLOGRAPHIC ORIENTATION, AND DENSITY OF A POCO GRAPHITE. Zukas, E. G.; Green, W. V.; Armstrong, P. E.; O'Rourke, J. A. (Los Alamos Scientific Lab., N. Mex.). [1971]. 13p. (CONF-720525-4). Dep. NTIS.

From seventy-fourth annual meeting of the American Ceramic Society; Washington, D. C. (6 May 1972).

POCO HPD-1 graphite is a very fine-grained, high-density, nearly isotropic graphite. However, it becomes less isotropic and less dense during high-temperature creep deformation. Changes in crystallographic orientation, density, and modulus were measured as functions of creep strain. The modulus changes induced by creep seemed to be related to the orientation and density changes. Modulus values were intermediate between calculated values based on the constant-stress model and those based on the constant-strain model. (auth)

38999 (ORNL-TM-3660) DEPTH OF TRANSMITTANCE OF RADIALLY EMITTED RADIATION INTO A CYLINDRICAL SOLID, WITH APPLICATION TO LITHIUM FLUORIDE. Spindler, Peter (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

The depth of transmittance of thermal radiation emitted by a central heater in a cylindrical solid is calculated with the mathematical relations of Czerny and Genzel. The absorption constant of the material is assumed to depend on wavelength and temperature. The approximate equation treating the material as a gray absorber is given for comparison. The formulas derived are applied to single- and polycrystal lithium fluoride, for which absorption constant data are available over a large wavelength range. (auth)

39000 (RD/B/N–2239) ELECTROCHEMICAL MEASUREMENT OF CARBON POTENTIAL. PART I. PRINCIPLES AND PRELIMINARY RESULTS. Hobdell, M. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1972. 25p. Dep. NTIS (U. S. Sales Only).

A method of assessing the "carburizing" or "decarburizing ability" (carbon potential) of a reactor coolant, with respect to structural or cladding materials, by simple voltage measurements, is described. The method is considered to have widespread application, both as a coolant monitor and as a research tool for studying such phenomena as carbon transfer and deposition. Initial attention, however, is directed towards the sodium-steel systems. The technique involves the equilibrium of carbon between a phase of interest and a membrane of α-iron; a voltage is measured between this membrane and a reference source of carbon across an electrolyte containing carbon in ionic form. Experiments described exploit some unique properties of α-iron and liquid sodium, i.e., high carbon diffusivity accompanied by low solubility (ppM) and an absence of stable carbides at relevant temperatures. A novel feature is the use of liquid sodium and an "inert" carbon transfer bond. (auth)

39001 (RD/B/N–2240) ELECTROCHEMICAL MEASUREMENT OF CARBON POTENTIAL. PART II. PRACTICAL ASPECTS. Hobdell, M. R.; Rowe, D. M. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1972. 12p. Dep. NTIS (U. S. Sales Only).

An apparatus and technique were developed for measuring carbon chemical potential (or activity) at 500 to 700°C. The method involved the equilibration of carbon between a material of interest (e.g., gas, liquid sodium, or steel) and a membrane of α-iron. A voltage was measured between this membrane and a reference source of carbon across an electrolyte containing carbon in ionic form. The particular design of apparatus described was ideal for laboratory-scale studies, and was used to demonstrate conclusively the validity of the method. The technique is considered to have widespread application both as a coolant "monitor" ("carbon meter"), and as a research instrument. (auth)

39002 PREPARATION OF THE MONOPHOSPHIDES AND MONOCHALCOGENIDES OF URANIUM AND THORIUM BY THE VOLATILE METAL PROCESS. Lovell, G. H. B.; Perels, D. R.; Britz, E. J. (Atomic Energy Board, Pretoria). J. Nucl. Mater.; 39: No. 3, 303-10(Jun 1971).

A new general method, called the volatile metal process, for the preparation of metallic monophosphides and monochalcogenides is described. In this process the specific metal, M_1, in the form of powder, is heated with phosphorus or the requisite chalcogen X in the form of a finely divided compound with a readily volatile metal, M_2. The reaction is represented by the equation $M_1 + M_2X = M_2X + M_2$ with the metal M_2 being removed as vapor. Suitable volatile metals are mercury, zinc, cadmium, magnesium, calcium, barium, and strontium; while M_1 can be almost any metal providing the reaction is thermodynamically possible. Using this process the synthesis of the monophosphides, sulfides, selenides, and tellurides of uranium and thorium have been carried out. A major advantage of the process is the ease with which the stoichiometry can be controlled. (auth)

39003 CONCRETE-POLYMER COMPOSITES: A PROGRESS REPORT. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Nucl. News; 15: No. 5, 49-51(May 1972).

The development status and research work being conducted on these composites is reviewed. Information is included on classification of concrete-polymer composites, forms of aggregate, and applications. Formulations of concrete–polymer composites used in solid waste disposal are tabulated. (J.R.D.)

39004 METHOD FOR THE STUDY OF THE PROPERTIES AND PREPARATION OF CERAMIC MATERIALS. Balek, V. (Karlova Univ., Prague). Radioisotopy; 13: No. 1, 207-24 (1972). (In Czech).

A survey is given of the application of the emanation method for the study of the thermal decomposition of raw materials used in the production of inorganic pigments, catalysts, and adsorbents and in production of cement, glass, heat resistant materials, electrotechnical ceramics, and in powder metallurgy. The emanation thermal analysis (ETA) is based on the study of release of atoms of radioactive inert gases incorporated in solids. It is used to follow up the process of preparation of ceramic materials immediately during their thermal treatment at high temperatures. Examples are given on the calcination study of some important industrial materials by means of ETA such as CaCO, mixtures of $CaO(CaCO_3) + Fe_2O_3$, mixtures of $ZnO + Fe_2O_3$, mixtures of their hydroxides, and mixtures of $BaCO_3 + TiO_2$. The emanation method is one of the few methods useful in the study of the kinetics of material calcination under isothermal conditions immediately in the course of the experiment. The high sensitivity of the emanation method may be used to fix even small differences in the crystal structure of materials, where the x-ray analysis is not satisfactory. The method may also be used to follow up the phase and crystallization changes with a very low thermal effect, which are undetectable by the method of differential thermal analysis (DTA). The feasibility of the emanation method for the study of structure incoordination of powdered and sintered materials and for the determination of the reactive sintering power of powdered materials is emphasized. (auth)

39005 TRITIUM COUNTING IN PLASTIC MATERIAL TESTING. Joks, Z.; Snajberk, J. (Statni Vyzkumny Ustav Materialu, Prague). Radioisotopy; 13: No. 1, 139-49(1972). (In Czech).

Methods of low-energy beta radiation measurement applicable in plastic material testing are described. Discussions are included on measurements using a windowless counter in the proportional region, measurements using a methane-filled proportional counter with a 0.01 mg/cm^2 window, and measurement using liquid scintillators on the Liquiszint FHT-770 G 2 counter. The liquid scintillation measurement was employed for water diffusion studies in polyester resin samples. The counts of the initial and final diffusion phase varied within the range $(1.6 \text{ to } 3.2) \times 10^{-8}$ $cm^2 \cdot s^{-1}$. (auth)

39006 INVESTIGATION OF GAMMA RADIATION EFFECTS ON WATER-RESISTING VARNISH AND PAINT COATINGS. Shigorin, V. G.; Egorov, B. N. Lakokrasoch. Mater. Ikh Primen.; No. 3, 24-6(May 1971). (In Russian).

The effects of γ radiation on the properties of two types of water-resistant coatings were investigated: epoxy resin enamel Sp-EK-4, and enamel type SP-KhSPE-5 (chlorosulfonated polyethylene). The epoxy coating exhibited the higher radiation stability, and was accordingly adjudged the better material for the protection of structural materials and plant equipment for an atomic electric power station. (tr-auth)

39007 EFFECT OF SWELLING ON THERMAL CONDUCTIVITY AND POSTIRRADIATION DENSIFICATION OF U_3Si. Hastings, I. J.; MacEwan, J. R.; Bourque, L. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Amer. Ceram. Soc.; 55: No. 5, 240-2(May 1972).

The effects of swelling porosity on the thermal conductivity of irradiated U_3Si fuel were deduced from electrical conductivity measurements on samples with pore volume fractions of 0.01 to 0.27. The Maxwell–Eucken expression adequately represents the data, with $\beta = 1.9 \pm 0.1$. Postirradiation annealing of samples at 400 to 750°C produced densification. Calculations confirmed that the pores in as-irradiated fuel were voids possibly containing a small amount of fission gas. Those retained after annealing were fission gas bubbles with internal pressure nearly in equilibrium with the surface tension of the surrounding solid. (auth)

39008 REACTIONS OF MODULATED MOLECULAR BEAMS WITH PYROLYTIC GRAPHITE. I. OXIDATION OF THE BASAL PLANE. Olander, D. R.; Siekhaus, W.; Jones, R.; Schwarz, J. A. (Univ. of California, Berkeley). J. Chem. Phys.; 57: No. 1, 408-20(1 Jul 1972).

Reaction of molecular oxygen as a modulated molecular beam with the basal plane of pyrolytic graphite is investigated. The graphite surface participates in the reaction in an unusual fashion. Oxidation tends to create a highly reactive surface while thermal annealing tends to deactivate the surface. The imbalance of these two competing processes results in slow changes in surface reactivity during the course of an experiment, which is manifest as hysteresis in the rate of CO production. The surface chemical reaction occurs on a much smaller time scale than the processes responsible for hysteresis. The data indicate that a two-branch, two-site mechanism explains both the hysteresis and the surface chemistry. Surface migration of adsorbed oxygen is shown to be a step in the production of CO. Carbon dioxide is barely detectable; its production rate is two orders of magnitude smaller than that of carbon monoxide at all temperatures. (auth)

39009 REACTIONS OF MODULATED MOLECULAR BEAMS WITH PYROLYTIC GRAPHITE. II. OXIDATION OF THE PRISM PLANE. Olander, D. R.; Jones, R. H.; Schwarz, J. A.; Siekhaus, W. J. (Univ. of California, Berkeley). J. Chem. Phys.; 57: No. 1, 421-33(1 Jul 1972).

The reaction of a modulated beam of molecular oxygen with the prism plane of pyrolytic graphite was investigated. Diffusional processes in the bulk dominated the response of the emission rates of CO and CO_2. The phase lags of these products relative to the impinging reactant beam indicated that the surface reactions were strongly affected by diffusion of oxygen in the grain boundaries and then into the grains of the pyrolytic graphite structure. This double diffusion process so strongly demodulated the product signals that the apparent reactivity of the prism plane was less than that of the basal plane. This reactivity inversion is peculiar to the ac modulated beam method and would not occur in dc (steady state) experiments. The reactivity of graphite which had been annealed to 3000°C was found to be an order of magnitude larger than that of the as-received material. This increase in reactivity was due to reduction of the demodulation effect which resulted from closing off diffusional paths in the bulk by annealing. Hysteresis of the type found in the basal plane reaction was observed in the prism plane reaction as well. Approximately one-tenth as much CO_2 was produced by the reaction as CO. Reaction with a beam enriched in oxygen-18 did not show complete statistical mixing of the isotopes of oxygen in the CO_2 product, suggesting that a significant portion of the CO_2 product was formed by a direct reaction of surface carbon with molecular oxygen. (auth)

39010 SURFACE AND INTERFACIAL ENERGIES IN LEAD/FUSED SALT SYSTEMS. Hodkin, E. N.; Nicholas, M. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 43: No. 3, 308-12(Jun 1972).

The surface and interfacial energies have been measured for a number of lead/fused salt systems of interest in the development of molten-salt fast reactors. The salt surface and interfacial energy values for the 70 NaCl–30 UCl_3/lead system are 0.25 and 0.28 Jm^{-2} respectively. The addition of UCl_4 or UO_2 increased or decreased, respectively the salt surface energies. (auth)

39011 TEFLON TUBES IN HEAT EXCHANGERS SPEED CHEMICAL MILLING OF Ti–6Al–4V FORGINGS. Metal Progr.; 101: No. 6, 85(Jun 1972).

Teflon heat exchanger tubes resist the corrosive reactions of the HNO_3–HF milling solutions.The heat exchangers were installed to control the temperature of the hot acid solution used in chemical processing large forgings for jet airplanes. The efficiency of the chemical milling process was increased and maintenance costs were lowered by addition of these heat exchangers. (J.R.D.)

39012 THERMODYNAMICS OF PLUTONIUM TRICHLORIDE IN FUSED CsCl. Smirnov, M. V.; Silin, V. I.; Skiba, O. V.; Babikov, L. G. This paper was summarized in At. Energ. (USSR); 30: No. 3, 298(Mar 1971) as paper No. 468/5794. (In Russian).

The emf method was used for measurements on the equilibrium potentials of plutonium in a fused CsCl medium containing 2.83×10^{-10} to 5.92×10^{-2} ionic fractions of plutonium, at the temperatures 655, 685, and 710°C. The complete thermodynamic equation of the dependence of the electrode potential Pu^{3+}/Pu relative to the chlorine reference electrode is: $E_{Pu^{3+}/Pu(melt)} = -3.873 + 11.6 \cdot 10^{-4}\ T + 0.661 \cdot 10^{-4}\ T \log [Pu^{3+}]$ V. It is reported that the equilibrium potential of plutonium in the CsCl melt is more electronegative than in NaCl or in NaCl–KCl. This is evidence of enhanced specific interaction between the plutonium trichloride and chlorides of the alkali metals as the radius of the solvent salt cation expands. It was found that, when other conditions are equal (temperature and concentration), the plutonium potential is negative by 0.3 V with respect to the uranium potential, which may be responsible for the way they separate out on an inert electrode from a CsCl melt containing a mixture of U^{3+} and Pu^{3+} ions. The change in the partial molar Gibbs free energy when plutonium trichloride forms by the reaction $Pu_{liq} + {}^{3}\!/_{2}Cl_{2gas} = PuCl_{3(melt)}$ in cesium chloride was determined from the formula $\Delta\bar{G}^{*}_{PuCl_3(melt)} - 3F \cdot E^{*}_{PuCl_3(melt)} = -268{,}000 + 80.2\ T$ cal/mole. The change in enthalpy and entropy when pure liquid plutonium trichloride is mixed with the CsCl melt was estimated by the respective quantities −55.8 kcal/mole and −46.0 cal/deg · mole. (auth)

39013 METHOD OF DETERMINING THERMODYNAMIC PROPERTIES AND KINETIC PARAMETERS IN THE EVAPORATION OF GRAPHITE. Ozhegov, P. I.; Khalitov, R. Sh.; Kunin, L. L. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 37: No. 11, 1711-16(Nov 1971).

Translated from Zavod. Lab.; 37: No. 11, 1337-40(Nov 1971).

Studies were made on the effects of the macrostructure (porosity) of graphite on the results of measurement of the rate of evaporation and the apparent vapor pressure by the methods of Langmuir and Knudsen, respectively. The results showed that if the carbon vapor is assumed to be monatomic, the rate of evaporation from an open surface according to Langmuir, expressed in units of effective pressure (atm), and the vapor pressure according to Knudsen (atm) can be described by linear relations. A comparison of the results showed that the calculated values of the rate of evaporation from an open surface of graphites of various degrees of porosity was in satisfactory agreement with experimental data. Some of the disagreement between the calculated results and the experimental data can be explained by the deviation of the vapor from the equilibrium state, which increased with decreasing degree of sample porosity. (P.C.H.)

39014 DETERMINATION OF THE RADIATION RESISTANCE OF VULCANIZATES IN THE COMPRESSED STATE. Degteva, T. G.; Zakirova, M. A.; Zhuravskaya, E. V.; Kuz'minskii, A. S. Sov. Rubber Technol. (Engl. Transl.); 29: No. 7, 17-19(Jul 1970).

In radiation aging of vulcanizates in the compressed state in air and in vacuum, the critical value of accumulation of irreversible residual deformation ϵ_{cr} is approximately 80 percent, while the corresponding value of relative elasticity β_{cr} is approximately 20 percent. The radiation resistance of compressed vulcanizates may be assessed by the absorbed dose at which ϵ_{cr} = 80 percent and β_{cr} = 20 percent. The rubbers discussed are natural rubber, polychloroprene, SBR, nitrile, polybutadiene, polyisoprene, and ethylene-propylene. (tr-auth)

39015 ESTIMATE OF THE RADIORESISTANCE OF HIGH-POLYMER MATERIALS THROUGH PROTRACTED IRRADIATION. Wuckel, L.; Koch, W. (Institutsteil fuer Metallphysik und Reinstmetalle, Dresden). Isotopenpraxis; 8: No. 1, 1-9(Jan 1972). (In German).

In applying polymers as building materials or structural materials in nuclear technology their resistance to radiation is very important. Evidence concerning the radiation resistance is available through extensive experiments only, carried out under a number of conditions. The behavior of the materials against low dose rates during a long period is of special interest. The results of investigations concerning the mechanical properties of polyethylene, polypropylene, PVC, polystyrene and of some rubbers irradiated under working conditions are discussed. (auth)

39016 THERMAL VIBRATIONS OF CARBON ATOMS IN GRAPHITE. Kelly, B. T. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Carbon; 10: No. 3, 324-5(Jun 1972).

Theoretical values for vibrational amplitudes of carbon in graphite are shown to be in good agreement with values derived by Bailey & Yates. It is concluded that the Komatsu model of lattice dynamics of graphite, used in the calculations, is satisfactory for thermal vibration amplitudes. (UK)

39017 HVEM DAMAGE STUDIES IN GRAPHITE. Fisher, S. B. (Central Electricity Generating Board, Berkeley, Eng.). Phil. Mag.; 25: No. 6, 1371-9(Jun 1972).

The High Voltage Electron Microscope (HVEM) was used in a quantitative manner to produce a displacement cross-section curve for electron irradiation of graphite at various beam energies. In addition, the temperature-dependence of interstitial loop formation was investigated and an activation energy for interstitial migration determined (1.3 ± 0.2 eV). The results are compared with previous studies using rather different techniques and the advantages of the present method are discussed. The threshold energy for carbon atom displacement in graphite is established as ≤40 eV. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstracts 38441 and 38575.

39018 (EUR-4799) COMPUTERIZED SYSTEM FOR THE APPLICATION OF FISSION NEUTRON CORRELATION TECHNIQUES IN NUCLEAR SAFEGUARDS. Birkhoff, G.; Bondar, L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1972. 6p. (CONF-710940-3). Dep. NTIS (U. S. Sales Only). EUR B.Fr. 25.-.

From International meeting on nondestructive measurement and identification techniques in nuclear safeguards; Ispra, Italy (20 Sep 1971).

A computerized system is described (data processor) which seems capable of resolving the complex problems involved in the application of correlation techniques by nonspecialized personnel (inspectors). The basic components of the system are explained as are calculation or measurement of neutron pulse distribution for a given sample, detector arrangements, and analysis by auto or cross correlation methods. A layout of the apparatus is given. The system has proved very useful in the domains of planning, execution, and analysis of measurements of fissile materials of various shapes and isotopic compositions. (auth)

Disposal and Storage

Refer also to abstract 38397.

39019 (CONF-720607-4) HIGH-LEVEL RADIOACTIVE WASTE DISPOSAL BY TRANSMUTATION. Claiborne, H. C. (Oak Ridge National Lab., Tenn.). [nd]. 5p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972)

The transmutation of long-lived radioactive nuclides to stable or short-lived nuclides by exposure to neutrons is discussed as a possible approach to the ultimate disposal of high-level radioactive waste. Results of calculations with the modified ORIGEN, an isotope generation and depletion code, are given for a typical PWR and a 3-group neutron spectrum. Application of recycling of the actinides will increase the cost of the nuclear fuel cycle primarily by requiring additional separations processes in reprocessing plants and remote operation of fuel fabrication plants. A crude estimate indicates the cost increase would be in the order of 0.1 mill/kwh(e). (P.C.H.)

·**39020** (ORNL-4768) SPONTANEOUS COMBUSTION, OXIDATION, AND PYROLYSIS OF COMBUSTIBLE SOLID WASTES CONTAINING TRANSURANIUM ELEMENTS IN COMBUSTIBLE AND NONCOMBUSTIBLE CONTAINERS. Godbee, H. W. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 36p. Dep. NTIS.

Solid wastes containing plutonium and other transuranium elements, frequently referred to as alpha wastes, are routinely produced during the operation of nuclear fuel production and spent fuel reprocessing plants as well as during the operation of AEC laboratories and production facilities. The transuranium contents of such wastes range from trace amounts to several grams per cubic foot. About one-half to two-thirds of the wastes, by volume, are combustible; however, reliable and efficient incinerators for reducing their volume have not as yet been developed. Therefore, it is desirable to evaluate the feasibility of storing them without pretreatment, such as incineration, in a final repository. A series of heating tests was carried out to study the oxidation and pyrolysis of typical combustible solid wastes in small combustible and noncombustible containers at temperatures of 90 to 215°C for periods of time ranging from 10 to 205 h. The combustible containers were plywood boxes having outside dimensions of 2 × 3 × 3 in. or 4 × 6 × 6 in. The noncombustible containers consisted of mild-steel drums with an open head, a bolt-ring closure, a hollow neoprene gasket, and a volume of 0.1 ft^3. A mixture of 75 wt % cellulosic materials and 25 wt % thermoplastic material was used to simulate alpha-contaminated combustible solid waste. In some cases, this mixture was wetted with nitric acid or sodium nitrate solution and dried before use. Each sample of the simulated waste was packed into the appropriate container to give a density of about 5 lb/ft^3—a value that corresponds closely to the average density achieved in actual practice. It was then heated to temperature at the rate of about 15°C/h. The buildup of pressure and the weight loss on heating were recorded. In three tests, CaO powder was added to the waste to serve as a getter for the water, carbon dioxide, and other acidic gases evolved during limited oxidation and pyrolysis. The wastes were only slightly affected by heating up to 130°C. However, as the temperature was increased above this level, the loss in weight and the depth of brown color increased. The measured weight losses, for approximately equal heating times, ranged from about 2 wt % at 145°C to about 4 wt % at 160°C, and to about 12 wt % at 200°C. The pressures attained in the drums varied from about 300 to 1200 in. H_2O (gage), about 200 to 1000 in. H_2O greater than expected from expansion of the original air in the drum. The pressures that developed after addition of CaO were less than those predicted from the expansion of air in the drum. The general conclusions drawn from these tests were that: combustible wastes in combustible containers should not be accepted at a final repository; combustible wastes in sealed noncombustible containers, such as DOT 17C and DOT 17H specification metal drums or equivalents, should be acceptable at a final repository; and the quantity of gases evolved during heating of these wastes can be reduced substantially by adding a getter such as CaO. (auth)

39021 NEW UPPER LIMIT TO THE LOCAL POPULATION II DENSITY. Weistrop, Donna (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astron. J.; 77: No. 5, 366-73(Jun 1972).

The nature of faint stars at high galactic latitudes was investigated through U, B, V photometry of several thousand stars between V = 12 and 18 near the North Galactic Pole. Magnitudes were determined from iris photometer measurements of plates taken with the 48-inch Schmidt telescope, with calibration provided by a photoelectric sequence in the field. Several models for the luminosity function and density distribution of Population II field stars were assumed. Assuming also that all stars bluer than $(B-V)_0 = 0.5$ and fainter than V = 17 are members of Population II, an upper limit to the local Population II density was calculated. A value of 1.1×10^{-4} (M/L) solar masses per pc^3 was found, where (M/L) is the mass–luminosity ratio of Population II field stars. The result was significantly lower than local densities computed from the number of nearby stars suspected of halo membership. Possible reasons for the discrepancy are discussed. (auth)

39022 WASTE DISPOSAL SYSTEMS FOR CLOSED CYCLE WATER REACTORS. Chave, Charles T. Nucl. Technol.; 15: No. 3, 36-48(Jul 1972).

Waste disposal systems for closed-cycle water reactor power plants were developed for the Shippingport, Yankee Rowe, and Connecticut Yankee plants in turn. Waste largely originates from moving water in and out of the reactor due to thermal expansion, for adjustment of boric acid concentration, and for control of tritium concentration. Escape of hydrogen from the coolant gives rise to gaseous waste. Recycling of boric acid and hydrogen reduces the waste discharge, but some water must be discharged to reject tritium. Evaporation provides strong leverage for water purification; it is proposed to send some evaporator vapor up the stacks for tritium and organic concentration control. Stripping hydrogen from the coolant to be processed before boric acid concentration simplifies the gas handling problem, while charcoal adsorption greatly reduces radioactive gas discharge to the atmosphere. The possibility of no waste discharge to the plant environment is foreseen. (auth)

Handling Equipment and Procedures

Refer also to abstracts 39025 and 40445.

39023 RADIATION DOSE RATES FROM UO_2–PuO_2 THERMAL REACTOR FUELS. Faust, L. G.; Brackenbush, L. W.; Smith, R. C.; Nichols, L. L.; Brite, D. W. (Battelle-Northwest Labs., Richland, Wash.). Nucl. Technol.; 15: No. 4, 249-56(Aug 1972).

Gamma and neutron radiation dose rates from various experimental fuel assemblies and from full-size commercial BWR and PWR power reactor fuel assemblies containing UO_2-PuO_2 fuel with high-exposure plutonium were measured. Maximum gamma and neutron dose rates encountered at 61 cm distance from the surfaces of the fuel assemblies were 6.5 mr/hr and 25 mrem/hr respectively. It was concluded that commercial reactor operators can handle fuel assemblies containing high exposure plutonium without excessive personnel exposure and with a minimum of special handling procedures. However, radiation shielding for some fuel fabrication steps will be necessary with plutonium of the type expected to become available during the late 1970's. (auth)

Transportation

39024 (BAW–312(Suppl.1)) LICENSING OF SHIPPING CONTAINER FOR RADIOACTIVE MATERIAL. Supplement 1. (Babcock and Wilcox Co., Lynchburg, Va.). Jun 1968. 15p. Dep. NTIS.

In support of an application concerning the licensing of a Y-12 Foamglas Shipping Drum, certain hypothetical accident conditions tests as prescribed in Appendix B, 10 CFR 71, are described. All test conditions were in accordance with the applicable parts of 10 CFR 71, and the results and an analysis of each are presented. The following hypothetical accident conditions were applied sequentially, in the order listed, to determine their cumulative effect on the container: free drop, puncture, thermal, and water immersion. (P.C.H.)

39025 (CONF-720607–9) USE OF THE MORSE MONTE CARLO CODE TO SOLVE SHIELDING AND CRITICALITY PROBLEMS OF SPENT FUEL CASKS. Morrison, G. W. (Oak Ridge National Lab., Tenn.); Odegaarden, R. H. (Division of Materials Licensing (AEC), Washington, D. C.); Straker, E. A. (Science Applications, Inc., Huntsville, Ala. (USA)). [nd]. 6p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

It is noted that the MORSE Monte Carlo Transport code can be used to advantage in solving the shielding and criticality problems of spent fuel casks. Results of calculations exemplifying the advantages of the MORSE code are presented tabularly. The example chosen is defined as a typical 4-assembly PWR depleted uranium shipping cask. The active fuel length is taken as 144 inches with a total cavity length of 170 inches. The top and bottom of the cask are assumed to have the same materials and thicknesses as the walls. The PWR fuel assemblies are assumed to contain 3.3 wt % enriched uranium oxide in 0.422 inch diameter rods on a 0.563 inch pitch. The Zr cladding is assumed to be 0.024 inch thick. (J.R.D.)

39026 (DPSPU–72–124–1) SAFETY SUMMARY REPORT: LP-50 TRITIUM CONTAINER. Packaging of Radioactive and Fissile Materials. Final Report. Rogers, R. F.; Scaggs, R. A. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). May 1972. Contract AT(07-2)-1. 48p. Dep. NTIS.

Elemental tritium is shipped at low pressure in an insulated container in compliance with AEC Manual Chapter 0529 (AECM 0529), Safety Standards for the Packaging of Radioactive and Fissile Materials. The package is not a radiological hazard under normal or hypothetical accident conditions. (auth)

39027 (MLM–1912) DOCUMENTATION OF DOT-SP-5948 FOR ATMX-500 AND ATMX-600 RAIL CAR PACKAGING. McDonald, E. P.; Griffin, J. F. (Mound Lab., Miamisburg, Ohio). 28 Apr 1972. Contract AT(33-1)-Gen-53. 48p. Dep. NTIS.

Information pertinent to the modification and use of the ATMX Rail Cars for which the Department of Transportation has issued special permit No. 5948 is presented. A complete physical and technical description of the package is presented. The packaging consists of a specially modified ATMX Series 500 or Series 600 Rail Car loaded with DOT Specification steel drums or wooden crates. A nuclear criticality safety analysis which was initially conducted for DOT-SP-6000 containers is applicable to packaging and shipment of fissile waste material in the ATMX Rail Cars and is included. In addition to the required criticality analysis for 30- and 55-gal containers, the report contains an evaluation of 15-gal containers which is not applicable to the DOT-SP-5948 permit. The results of the analysis indicate that when the quantities of any fissile isotope in the 55- and 30-gal drums are restricted to a maximum of 138 and 90 g respectively, then that container can be shipped as Fissile Class I. Design and development considerations regarding the packaging concept and modification of the ATMX-500 Rail Car are presented. Tables, dimensional sketches, sequential photographs of the structural modifications, technical references, loading and shipping guidelines, Mound Laboratory's experience in using this container, and a copy of permit DOT-SP-5948 are included. (auth)

39028 (NLCO–1089) STEEL BANDED WOODEN SHIPPING CONTAINERS FOR SLIGHTLY ENRICHED URANIUM BILLETS, INGOTS, AND FUEL CORES. Dunaway, D. L. (National Lead Co. of Ohio, Cincinnati). 17 Apr 1972. Contract AT(30-1)-1156. 18p. Dep. NTIS.

The design and design standards for two general types of steel-banded wooden containers for shipping slightly enriched (up to 2.1% ^{235}U) uranium are described. One type includes boxes with lids for shipping fuel cores. The other type includes pallets with covers for shipping uranium metal billets and ingots. (L.C.L.)

39029 (ORNL–TM–3744) ANALYSIS OF THE ORNL LOOP TRANSPORT CARRIER. Watkin, D. C. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 80p. Dep. NTIS.

The Oak Ridge National Laboratory Loop Transport Carrier is used for the inter-site transport of radioactive fueled experimental capsules and fuel elements. The cask was analytically evaluated to determine its compliance with the applicable regulations governing containers in which radioactive materials are transported, and that evaluation is reported herein. Computational procedures were used to determine the structural integrity and thermal behavior of the cask relative to the general standards for normal conditions of transport and the standards for the hypothetical accident conditions. The results of the evaluation show that the cask is in compliance with the applicable regulations. (auth)

39030 (TID–25861) SHIPMENT OF RADIOACTIVE MATERIALS. Shappert, L. B. (Oak Ridge National Lab., Tenn.). 26 Oct 1971. 21p. (CONF–720522–6). Dep. NTIS.

From seventy-second national meeting of the American Institute of Chemical Engineers; St. Louis, MO. (21 May 1972).

Discussion is presented on: types of packages, types of shipments, fuel cycle, projected shipments in the fuel cycle, modes of transportation, frequency of accidents, number of accidents, accident experience, insurance losses due to transportation incidents, and the radiological assistance program. (P.C.H.)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 39063 and 39891.

39031 (CEAL–1057) CALCULATIONS AS TO HOW LARGE A DOSE-RATE OF SYNCHROTRON RADIATION WOULD BE RECEIVED BY A PERSON STANDING CLOSE TO THE CEA RING OR BYPASS WHEN THERE IS A 5-mA-ave 3-GeV BEAM STORED THERE. Shurcliff, W. A. (Cambridge Electron Accelerator, Mass.). 30 Mar 1972. Contract AT(30-1)-2076. 27p. Dep. NTIS.

The vacuum chambers of the synchrotron ring proper include three stainless steel windows that have thicknesses of 10, 30, and 60 mils. Normally, these windows are not used and are kept covered by $\frac{1}{8}$-inch-thick stainless-steel clip-on cover plates. Calculations of the synchrotron radiation incident on the thinnest window when there is a 5-mA-ave 3-GeV beam in storage show that, if a person were to stand at such a position, 10 ft from the window, that his eye was in the path of the synchrotron radiation that emerges through window and cover, his eye would receive only a very small dose-rate, <1 mrem/s. If for some reason the window cover were absent, the dose rate would be large, ~0.5 rem/s. Two of the four 3-mil-thick stainless steel windows of the bypass are normally covered by 1-inch-thick lead plates, and the other two are normally left uncovered in order to minimize the amount of mass lying between bypass interaction region and bypass on-axis luminosity monitors. The 2-ft-long region between uncovered window and monitor is partially enclosed by massive equipment, and it would be difficult for a person to get his head into this region. Calculations show that if, somehow, a person were situated so that one eye was in the path of the synchrotron radiation emerging from an uncovered window with a 5-mA-ave 3-GeV beam in storage, this eye would receive a dose rate of ~10,000 rem/s. Interposing the 1-inch-thick lead plate would reduce the rate to <1 mrem/hr. (Interposing merely a $\frac{1}{8}$-inch-thick stainless steel plate would not be adequate: the dose rate would still be large, ~10 rem/s.) The appendix discusses the 2.5-GeV case, which yields dose rates that, typically, are one order of magnitude less. (6 figures, 2 tables) (auth)

39032 SOME REMARKS ON HEAVY ION ACCELERATION AND HEAVY ION ACCELERATORS. Schmelzer, Christoph (Gesellschaft fuer Schwerionenforschung, Darmstadt, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 16-21(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The production of high-charge states and the advantages of foil vs gas stripping are first discussed. Problems associated with handling beams of highly ionized particles, such as particle loss due to residual gas molecules, are considered. Specifications for a heavy-ion accelerator are presented, and the abilities of various accelerator combinations to meet these are examined. Two new concepts for heavy-ion acceleration, electron-ring and superconducting accelerators, are briefly mentioned. (6 figures, 2 tables) (R.W.R.)

39033 ACCELERATION OF HEAVY IONS AT THE PRINCETON PARTICLE ACCELERATOR. Isaila, M. V.; Prelec, K.; White M. G. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 204-7(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Modifications to the Princeton Particle Accelerator (PPA), such as a pulsed heavy ion source, an extended-range radiofrequency system, and vacuum system improvements, allowed the adaptation of the 3-GeV proton synchrotron to the acceleration of heavier ions. Acceleration of nitrogen ions in a charge state of N^{5+} and N^{6+} to an energy of 4 and 7 GeV was achieved starting in July 1971. Present average intensities run at about 3×10^5 and 2×10^5 particles/sec. Expectations for acceleration of neon and argon are discussed. (6 figures, 3 tables) (auth)

39034 UHF LOSSES IN SAPPHIRE AND RUBY AT LOW TEMPERATURES. Ceperley, Peter H.; Castle, J. G. Jr. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 222-5(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Losses in Al_2O_3 rods, placed along the axis of a superconducting helical resonator, were observed at frequencies from 130 MHz to 450 MHz and at sample temperatures up to 20 K. Losses at 2 K corresponding to ϵ''/ϵ' of 0.8×10^{-6} were found in the two different grades of sapphire tested. Losses associated with Cr^{+3} impurities were larger, corresponding to χ''/χ' of 6×10^{-6} for pink ruby and 2×10^{-5} for red ruby at 130 MHz and 3 K. The ruby losses decreased with increasing temperature and increasing frequency. Magnetic coupling within the Cr^{3+} spin system seems to account for most of the ruby losses. (3 figures) (auth)

39035 HEAVY ION BEAM ACCELERATION: ECONOMICS AND METHODS USING THE LESS ABUNDANT ISOTOPES. Burn, N.; Bender, L. B.; Brown, P. W. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 239-42(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

There are several well-established methods of producing negatively-charged heavy-ion beams. When applied to the less abundant isotopes, these standard methods can become prohibitively expensive. Several techniques were devised which make operation with separated isotopes comparable in cost with normal operation. These techniques are reviewed, and methods are outlined by which further improvements in economy could be made. (3 figures, 2 tables) (auth)

39036 ION LOADING AND ACCELERATION IN A STATIC-FIELD ERA. Reiser, Martin (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 280-6(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The design concept of the Maryland Static-Field ERA is briefly reviewed. Two schemes of ion loading are being studied: fast loading by passing the electron ring thorough a gas region with pressures in the range of 10^{-3} torr, and stopping of the ring by resistive wire damping and slow ion loading while the ring is trapped in a small mirror well. Acceleration of the ions by the expansion and external E-field methods is discussed, and the pertinent equations are presented. Parameters for a possible heavy-ion ERA producing 10^{11} or more ions of energies up to 1500 MeV (uranium) are estimated. (8 figures) (auth)

39037 COLLECTIVE ION ACCELERATORS WITH TRANSVERSE MOTION OF THE RING. Boscolo, I. (Istituto di Fisica, Lecce, Italy); Coisson, R.; Leo, M.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 287-9 (Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A collaboration from the Bari and Lecce Universities started some theoretical and experimental work on a new type of collective ion accelerator. Ion acceleration can be obtained by the electric field produced by an electron ring which drifts perpendicularly to the external magnetic field. The model machines, which are now under construction, are called ANEL, from the Italian translation of E.R.A. ANEL 1 is a model of a static field ERA, which will be used to study the injection, stability, and ionization problems. ANEL 2 is a device designed to study the feasibility of a "collective synchrotron". The first injection tests are planned for 1972. (2 figures, 2 tables) (auth)

39038 PRODUCTION AND ACCELERATION OF IONS BY INTENSE RELATIVISTIC ELECTRON BEAMS. Graybill, S. E. (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 292-6(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The experimental arrangement for the production of the electron beam (E_{max} = 1.7 MeV) and the detection of ions along the electron beam axis is first described. Since typical ion pulses are only a few nanoseconds in duration, the time-of-flight method was used to measure arrival times of ions of hydrogen, deuterium, helium, and nitrogen gas. A magnetic spectrometer was used to determine the charge states of the ions produced. It was found that 10^{13} 5-MeV protons were produced in a 3-ns pulse. Charge states of 4 to 6 for N and 6 to 12 for Ar were produced in pulses of about 15 to 20 ns. Neutron yields were obtained from D(d,n), Be(p,n), Be(d,n), and Be(α,n) reactions. The neutron yield data indicated that ion acceleration ceases at pressures higher than a few millitorr. (8 figures, 3 tables) (R.W.R.)

39039 REVIEW OF ION ACCELERATION RESEARCH AT PHYSICS INTERNATIONAL COMPANY. Yonas, G. (Physics International Co., San Leandro, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 297-300(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Results of experiments directed at accelerating ions using intense electron beams are discussed. A comparison is made with a similar process in a vacuum discharge, and a collective ion acceleration model is presented. (4 figures) (auth)

39040 ACCELERATOR SYSTEMS FOR HEAVY IONS. Rostoker, Norman (Maxwell Labs., Inc., San Diego, Calif. Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 301(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Intense electron beams can be trapped in open or closed confinement systems. If adequate containment ($n\ \tau \gtrsim 10^{12}$) can be achieved, sources of highly stripped ions could be developed for conventional accelerators. Pulses of highly stripped ions have been obtained with lasers and spark discharges. Accelerators adapted to such pulsed sources are also considered. (auth)

39041 REMARKS ON SUPERCONDUCTING HEAVY ION LINACS. Klein, H. (Univ., Frankfort am Main); Kuntze, M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 304-6(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Although rf superconductivity is not needed for heavy-ion linacs on the basis of power handling and dissipation, there are a number of points in favor of a superconducting machine: the higher field strengths achievable result in a reduced overall length, CW operation is easy, unconventional structures can be used because of relaxed shunt-impedance conditions, and total costs appear to be below those of a normal-conducting machine. The accelerating structure is discussed in some detail. Problems remaining to be solved are the development of a CW ion source and the effects of aging and radiation on superconductors. (1 table, 17 references) (R.W.R.)

39042 SOME REMARKS ON SUPERCONDUCTING HEAVY ION LINEAR ACCELERATORS. Glavish H. F. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 307-8(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Superconducting linacs for heavy ions have a number of attractive features with regard to beam dynamics. Since each accelerating gap can be independently controlled, any desired velocity profile for the machine is available; such a machine could accelerate U ions, protons, and electrons. Two types of accelerating structures, the helix and the reentrant cavity, are discussed. A possible arrangement for a superconducting linac and parameters for some reentrant cavities are given. (2 figures, 1 table) (R.W.R.)

39043 SUPERCONDUCTING HILACS. Sierk, A. J.; Tombrello, T. A. (California Inst. of Tech., Pasadena). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 309-11(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Progress on the Caltech study of the feasibility of building a superconducting hilac is reported. Helical waveguides are used as the accelerating structures. Because of ease of fabrication, the resonators are lead-plated copper. The problems of multipactoring and mechanical oscillation are addressed. The desired mass and energy ranges for which a superconducting linac might be constructed are discussed. It is implied that, with only marginal advantages over a room-temperature hilac and much worse performance distinctly possible, there is no strong justification for pushing development of a superconducting hilac. (3 figures) (R.W.R.)

39044 EXPERIMENTAL INVESTIGATION OF METHODS FOR INCREASING THE LIMITING CURRENT IN A LINEAR ELECTRON ACCELERATOR. Zykov, A. I.; Kramskoi, G. D.; Fursov, G. L. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1289-93(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 28-32(Sep-Oct 1971).

A section of irised waveguide in a linear accelerator was investigated. The effects of the focusing magnetic field, the Q of the structure, and the matching of the end devices of an irised EH_{11} waveguide on the development of transverse instability in an electron beam having an energy of 5.5 MeV, without fundamental E_{01}-wavepower insertion into the waveguide, were studied. (8 figures) (auth)

39045 FREQUENCY CHARACTERISTICS OF INPUT IMPEDANCE AT TRAVELING-WAVE LINAC'S ACCELERATING STRUCTURE. Irie, Koichi (Mitsubishi Electric Corp., Amagasaki, Japan). Jap. J. Appl. Phys.; 11: No. 6, 905(Jun 1972).

The frequency characteristics of the input VSWR of the accelerating structure of a traveling-wave linac show ripple when measured with CW signals. It is shown that the frequency difference between adjacent minima of the VSWR is equal to that between the adjacent resonances in the dispersion relation of the structure. (1 figure) (R.W.R.)

39046 RADIATION-PHYSICS CHARACTERISTICS OF THE B5M-25 BETATRON OPERATING AS A BREMSSTRAHLUNG EMITTER. Kozlov, A. P.; Bazhanov, E. B.; Dumov, V. I. (Inst. of Oncology, Moscow). Med. Radiol.; 17: No. 4, 79-83(Apr 1972). (In Russian).

The fundamental radiation-physical characteristics of a new series of medical betatron—Type B5M-25—were investigated during operation as a bremsstrahlung emitter. Calibration of the energy scale of the accelerator was conducted by the method of determining the threshold of photonuclear reactions. The intensity of the bremsstrahlung beam and the ratio of the energy flux density to absorbed dose at a fixed depth in a water phantom were measured. The effective attenuation coefficients and the thickness of copper for half-absorption were determined, and the effective bremsstrahlung energy of the betatron was evaluated. (2 figures, 1 table) (tr-auth)

Auxiliaries and Components

Refer also to abstracts 39670 and 39678.

39047 (BNL-16764) SUPERCONDUCTORS FOR PULSED MAGNETS. McInturff, A. D. (Brookhaven National Lab., Upton, N. Y.). [1971]. 9p. (CONF-720513-3). Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

A simple model for flux pinning is sketched which yields many of the useful critical-current relations and assigns physical significance to the various parameters, as well as indicates the best metallurgical processes to follow in order to obtain a given superconducting property. Procedures are then given for obtaining multifilamentary Nb−Ti composites that can be formed into conductors (braids) for use in winding pulsed magnets (other multifilamentary superconductors can be treated similarly). The resulting conductor, in general, will not be "cryogenically" stable, but it will satisfy both adiabatic and dynamic stability criteria over the frequency range in which it is designed to operate. The rate of magnetic field change will, however, be restricted to less than 10.0 tesla/s. (13 figures, 2 tables) (R.W.R.)

39048 (LYCEN-7179) STUDY AND DEVELOPMENT OF QUADRUPOLAR FOCUSING LENSES FOR A HELICOIDALLY FOCUSED HEAVY ION ACCELERATOR. Meyrand, Gabriel (Lyon Univ. (France). Institut de Physique Nucleaire). Nov 1971. 68p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The results of investigations on quadrupole focusing lenses intended for the drift tubes of the interdigital structure of the Lyon heavy-ion accelerator are presented. Curves are given for the different forms chosen. The radius of curvature of the pole for a given pole width (Xaler program) and the aberration limit are obtained from these curves. Measurements demonstrate that it is necessary to consider supplementary aberrations (1 to 2%) due to the extremities of the lens and its imperfect symmetry. A helicoidal system was studied in order to obtain a focusing system requiring less steep magnetic gradients. It is shown that, for an elementary $\pi/4$ rotation, this system, in the most unfavorable case, is equivalent to the ++−− classical system with regard to the acceptance; in contrast, it presents a stability zone which can be used with small gradients, as resonances due to coupling between longitudinal and radial oscillations do not have an adverse effect. (France)

39049 PONDEROMOTIVE OSCILLATIONS IN A SUPERCONDUCTING HELICAL RESONATOR. Ceperley, Peter H. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 217-21(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The onset of ponderomotive oscillation, a radiation pressure-driven mechanical oscillation, at 120 Hz was observed at low field strengths in a superconducting 130-MHz helical resonator suitable for use in a heavy-ion accelerator. Thresholds were observed over a wide range of parameters, such as RF Q's from 10^5 to 10^8 and mechanical Q's from 8×10^3 to 2×10^5. A typical minimum threshold value was 10^{-8} joule of RF energy in the resonator. A theory is presented which quantitatively explains all the threshold data. Methods of damping ponderomotive oscillations are discussed. (8 figures) (auth)

39050 PROPERTIES OF A SUPERCONDUCTING NIOBIUM TEST CAVITY AT 350 MHz. Ben-Zvi, I.; Castle, J. G. Jr.; Ceperley, Peter H. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 226-30 (Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Measurements of Q values as a function of heat treatment and rf field strength for a reentrant niobium test cavity having a gap of one cm indicated that the high-field performance was limited by field emission at 25 MV/m peak surface field. Q values at low power of 1.2×10^9 at 4 K and 7×10^9 at 2 K were degraded to 2×10^8 at 4 K and 3×10^8 at 2 K after rf processing. Excellent stability was obtained by mechanical control of the resonant frequency of the cavity by using a piezoelectric motor made of quartz transducers. The fractional tuning rate of the uncontrolled cavity resonance was observed to be 1.7×10^{-6} per Torr. (4 figures, 1 table) (auth)

39051 IMPROVED CYCLOTRON r-f SUPPLY: A CYCLOTRON UTILIZING THIS IMPROVEMENT. Delphin, Pierre (to Thomson-CSF). French Patent 2,076,785. 20 Sep 1971. Filed 28 Jan 1970. (In French).

An r–f system for feeding the dee electrodes of a cyclotron is presented. It consists of an enclosure formed by metallic plates, which is evacuated, and two electrodes, both fed with an r–f potential via a support insulated from the enclosure. This support forms the inner conductor of a transmission line connected to the r–f source, and is provided with a movable short circuiting piston. At least part of each support is vertical and crosses the two horizontal faces of the enclosure through two vacuum tight insulators. (France)

39052 COMPACT TUBE FOR ACCELERATING ELECTRONS. Abramyan, E. A.; Balykov, G. F.; Bochkov, G. A.; (and others) (Inst. of Nuclear Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1294-6(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 32-4(Sep-Oct 1971).

A sealed accelerator tube having magnetic focusing is described which transmits a current of approximately 1 A in pulses having a length of approximately 2 μs. For a tube length of 27 cm the working voltage is 500 kV. The sectioned insulator envelope is soldered together from glass rings 2 cm in diameter having a length of 1 cm. The permanent magnets which create the focusing field are mounted outside the vacuum. (1 figure) (auth)

39053 STABILIZATION OF THE ENERGY OF AN ACCELERATOR TANK CIRCUIT. Furman, E. G. (Tomsk Polytechnic Inst., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1297-9(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 35-7(Sep-Oct 1971).

A simple and effective method is considered for stabilizing the energy of a tank circuit and, consequently, also the amplitude of the magnetic field of an electromagnet for pulsed supply of energy from an unstabilized power supply. A block diagram of the stabilization system and certain results of testing it are presented. (3 figures) (auth)

39054 MEASUREMENT OF THE FREQUENCY OF COHERENT OSCILLATIONS OF AN ELECTRON BEAM IN A SYNCHROTRON. Vizir, B. A.; Nikitin, M. M. (Tomsk Polytechnic Inst., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1300-1(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 37-8(Sep-Oct 1971).

The well-known methods of measuring the frequency of electron-beam oscillations in a synchrotron require the placement of pickups in the vacuum chamber and have comparatively complex electronic measurement systems. In the method described the measurement of the frequency and character of the amplitude variation of the oscillations of the bunch center of gravity is achieved using the synchrotron radiation from the electrons by means of a light filter having an inhomogeneous optical density and a photomultiplier. The equipment used is simple and allows measurements to be carried out in the frequency range extending up to hundreds of megacycles. (2 figures) (auth)

39055 MEASUREMENT OF THE DENSITY DISTRIBUTION OF ACCELERATED PARTICLES IN PULSED BEAMS. Knyazyatov, A. S.; Mal'tsev, V. V. (Inst. of Atomic Energy, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1307-9 (Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 42-5(Sep-Oct 1971).

A calorimetric method was developed for measuring the density distribution of the current along the radius of a beam. The measurements may be carried out at various distances from the emission aperture of the source without disrupting the vacuum. The procedure is applicable to the investigation of an ion beam from a pulsed source with occluded gas at an ion energy in the beam equal to 100 keV, and for investigation of the density distribution in a beam of accelerated hydrogen atoms having the same energy. (4 figures) (auth)

39056 ESTIMATION OF RADIATION PROBLEMS AROUND HIGH ENERGY ACCELERATORS USING CALCULATIONS OF THE HADRONIC CASCADE IN MATTER. Ranft, J. (Karl-Marx-Univ., Leipzig). Particle Accel.; 3: No. 3, 129-61 (Jun 1972).

Monte Carlo calculations of the hadronic extranuclear cascade are described. These calculations are applied to a variety of radiation problems around high energy accelerators, for instance: estimation of shielding requirements, induced radioactivity, direct radiation doses, and radiation heating. Good agreement, usually better than within a factor of two, is found with experimental data at present accelerators. (151 references). (auth) (UK)

39057 ELECTRON LOADING OF SUPERCONDUCTING RF CAVITIES. Halbritter, J. (Kernforschungszentrum, Karlsruhe, Ger.). Particle Accel.; 3: No. 3, 163-74(Jun 1972).

A superconducting cavity can respond in unexpected ways to high rf fields. Some of these effects are related to electrons emitted by the cavity surface in the presence of electric rf fields. The interactions between these electrons and the rf fields can manifest themselves in barriers which prevent the increase of stored rf energy. These barriers are caused by resistive and capacitive loading of the rf mode, permitting a pulling of the oscillating frequency by more than 10 kHz above the low field eigenfrequency ($f_0 \approx$ GHz). Methods are developed to describe the interaction of electron currents with rf modes in the lowest order of a perturbation theory. With this theory it is possible to describe the (meta)stability of nonlinear oscillations, a question relevant for the frequency pulling state mentioned. In addition it is shown how one can identify experimentally the types of trajectories causing a barrier from the ratio of eigenfrequency and bandwith increase. This identification can serve as an aid in eliminating the observed barriers. (36 references) (auth) (UK)

39058 IMPROVED BEAM ENERGY RESOLUTION FOR A TANDEM ACCELERATOR. Dzubay, T. G. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Bilpuch, E. G.; Purser, F. O.; (and others). Nucl. Instrum. Methods; 101: No. 3, 407-12(1972).

A system which significantly improves the energy resolution to the proton beam of an FN tandem Van de Graaff accelerator has been developed. An associated beam is used to generate correction signals which are applied to the target in order to compensate for fluctuations in the beam energy. An overall experimental resolution of 625 eV was observed for a narrow resonance in ^{55}Co at $E_p = 3.2$ MeV; a resonance in ^{13}N at $E_p = 14.2$ MeV was also observed with resolution superior to that previously obtained. The resolution depends strongly upon which molecular hydrogen component is selected at the charge exchange ion source. (auth)

39059 SIMPLE USE OF A DIGITAL MULTIMETER FOR BEAM CURRENT INTEGRATION. Schmid, K.; Mueller, H.; Ryssel, H. (Technische Univ., Munich). Nucl. Instrum. Methods; 101: No. 3, 503(1972).

The use of a digital multimeter or voltmeter as a current integrator is illustrated schematically. Using digital measuring instruments without voltage to frequency conversion the effective integration will be performed only during the integration time of the instrument. If the measuring time, however, is long compared to the cycle time of the integration this disadvantage can be ignored. (auth)

39060 RADIOACTIVITY IN EARTH INDUCED BY HIGH ENERGY ELECTRONS. Thomas, R. H. (Stanford Univ., Calif.). Nucl. Instrum. Methods; 102: No. 1, 149-55(1972).

The total quantity and spatial distribution of γ emitting radionuclides induced in earth irradiated by 1 GeV electrons is estimated. Some measurements of the radioactivity induced in an earth beam dump at the Mark III 1 GeV electron accelerator of the High Energy Physics Laboratories of Stanford University are described. These measurements suggest that environmental pollution of ground water system will be insignificant from earth beam-dumps at high energy electron linear accelerators. (auth)

39061 MODULATION AND STABILIZATION OF THE RF GENERATOR IN A SYNCHROCYCLOTRON. Alekseev, V. A.; Gerasimov, V. P.; Pavlov, E. P. (Scientific-Research Inst. of Electrophysical Equipment, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1951-3(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2459-62(Nov 1971).

A system of plate modulation and stabilization is described for controlling and stabilizing the amplitude of the rf level according to a specified program directly at the accelerating gap of a synchrocyclotron; the program is designed for optimum capture and for maximum intensity of a beam with finite energy. The final control stage uses a shunt-amplifier control system. (5 figures) (auth)

Ion Sources, Injection, and Extraction

Refer also to abstract 38467.

39062 (LYCEN-7207) PIG SOURCES. Tauth, T.; Chabert, A. (Lyon Univ. (France). Institut de Physique Nucleaire). Jan 1972. 14p. (In French). Dep. NTIS (U. S. Sales Only).

Currently operating PIG ion sources provide acceptable multicharged heavy ion beams. It is shown that a thorough knowledge of the physical phenomena taking place in the sources is necessary if a higher yield is to be obtained. Various types of sources (hot and cold cathodes) are reviewed and their performances given. (43 references) (France)

39063 INTERNATIONAL CONFERENCE ON MULTIPLY-CHARGED HEAVY ION SOURCES AND ACCELERATING SYSTEMS, GATLINBURG, TENNESSEE, OCTOBER 25—28, 1971. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 1-320(Apr 1972). (CONF-711021).

Separate abstracts were prepared for 43 of the papers presented at this conference. Abstracts for the remaining 11 papers have already appeared in NSA. For abstracts of these papers see CONF-711021 in a cumulative report number index. (R.W.R.)

For abstracts of individual papers see: 39032—39043, 39049, 39050, 39064—39085, 39460—39462, 39497, 39498, 39891, and 40053.

39064 SURVEY OF MULTICHARGED ION SOURCES PHYSICS AND SOME EXTRACTION PROBLEMS. Septier, A. (Univ. Paris, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 22-34(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A review is given of fundamental processes leading to the production of multicharged ions by electron—atom collision: direct electron ejection, the Auger process, and electron shake-off. Results concerning ionization cross sections by electron impact are discussed. Some approximate methods allowing fairly good knowledge of the ion population in different types of ion sources (hot plasma devices, laser ion sources, and electron bombardment and discharge sources) are considered. Some problems concerning emittance and brightness of heavy multicharged ion sources are also examined. (6 figures, 2 tables, 74 references) (auth)

39065 DUOPLASMATRON ION SOURCES. Illgen, J.; Kirchner, R.; Schulte, J. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 35-47(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A survey of questions related to the production of multiply charged ions with the duoplasmatron ion source is given. In spite of differences of the multiply charged ion source and the mass separator type, design considerations show that high containment is a common feature to be attained in both. Multiply charged metal ions are produced by material evaporation into the magnetically confined anodic plasma and auxiliary gas feed into the cathode discharge regions. Energy spreads of ion beams from the low- and the high-arc current sources are compared. The duoplasmatron ion source proves to be a hygienic source of high containment that permits the production of medium charge states up to 9^+ for xenon at modest energy spread and good brightness of the extracted ion beam in a high current-low voltage discharge mode. (8 figures, 5 tables) (auth)

39066 REVIEW OF PIG SOURCES FOR MULTIPLY CHARGED HEAVY IONS. Bennett, J. R. J. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 48-68(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A review is given of the performance and characteristics of the various types of PIG sources used for the production of multiply charged ions. They are able to produce ions with a high charge-to-mass ratio for the lighter elements up to about neon, but for heavier elements the ratio falls steadily. Charge states do not exceed 8 to 10 for argon and 12 for xenon. Although the development of the multiply charged PIG source, since its original inception, has been very slight, it is still the most powerful practical design in existence at this time. A brief description of the general characteristics and the mechanisms involved in the PIG discharge is given, including a discussion of multiply charged ion production. (28 figures, 2 tables, 82 references) (auth)

39067 UNILAC ION SOURCE AND INJECTION SYSTEM. Krupp, H. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 69-73(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The design of the UNILAC injector was governed principally by aspects of maintenance and reliable performance. Thus, open-air 254-kV high-gradient single-gap acceleration was chosen for Uranium 11^+ particles; this choice corresponds to an injection energy of 11.7 keV/amu and a charge-to-mass ratio of 0.046. It allows fast ion source changes because only a short time for tube conditioning is required, and it takes into account the lifetime of present sources for multiply charged heavy ions. Two independent Faraday rooms, symmetrically arranged to the axis of the main accelerator, each house a 300-kV oil-insulated Cockcroft—Walton generator, a duoplasmatron, and a Penning source with the associated equipment. Thus, a fast switch-over to the stand-by source is provided in case of an ion source failure. Magnetic quadrupole lenses focus and match the beam through a magnetic deflection system, a 50-Hz chopper, and a double drift buncher into the linac. (6 figures, 2 tables) (auth)

39068 CHARACTERISTICS OF A COLD CATHODE TYPE PENNING SOURCE AND LOW ENERGY ISOTOPE SEPARATION OF HIGH CHARGE STATES. Wolf, B. H. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 74-9(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Measurements of voltage, current, and gas-flow dependencies of a cold-cathode Penning source using different cathode materials are reported. The influence of the discharge parameters (arc voltage, arc current, magnetic field, and gas flow) on the production of higher charge states was studied. The highest observed charge states were Ar^{9+}, Kr^{12+}, and Xe^{13+}. The cold-cathode-type Penning source with radial extraction proves to have sufficiently low energy spread to permit isotope separation in the source-magnet field. Results for Ar^{2+}, Kr^{4+}, and Xe^{7+} are given, along with emittance measurements. (14 figures) (auth)

39069 EMITTANCE MEASUREMENTS FOR N^+ AND N^{2+} IN AN ION BEAM FROM A CYCLOTRON ION SOURCE. Toman, M.; Reiser, M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 80-3(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The radial density profiles and emittance were measured for N^+ and N^{2+} beams from a Penning-type ion source that has a hot filament. It was found that the emittance for an extraction voltage of 12 kV and for 50% of the beam was 21 cm-mrad for N^+ and about 12 cm-mrad for N^{2+}. The difference between these two areas may, in part, be explained by a charge-state dependence due to different velocities of the two ion beams. (5 figures) (auth)

39070 PENNING ION SOURCE FOR MULTIPLY CHARGED IONS. Baumann, H.; Heinicke, E.; Bethge, K. (Univ., Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 88-90(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The ion source described allows the production of considerable intensities of highly charged ions. The electron density is increased by an additional electron gun. The decrease of the ratio of neighboring charge states is similar to the decrease of the ratio of the ionization cross sections by electron impact: from this similarity one-event ionization processes are assumed to be of major importance in the performance of this source. (4 figures) (auth)

39071 POWER SUPPLIES FOR COLD CATHODE PENNING DISCHARGE ION SOURCES. Mosko, S. W. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 91-2(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

For the generation of heavy ions at high charge states, the cold-cathode Penning discharge ion source requires a power supply capable of both the high potential essential for striking an arc and the high current for sustaining it. A series-regulated power supply developed at Oak Ridge provides up to 6 kV of striking voltage and up to 12 amperes of arc current. The power supply operates in a constant current mode with the arc voltage dependent on the gas pressure in the ion source. With this source in the ORIC, the typical operating conditions are 5 to 10 amperes arc current, 600 to 2000 volts arc potential, and 5 to 20 kW power dissipation in the arc. A larger power supply is planned for extending the arc current to about 25 amperes. Various arrangements, including pre-regulators and multiple power supplies, are under consideration to reduce power dissipation in the series regulator tubes. (3 figures) (auth)

39072 NEW HEAVY ION SOURCE AND RECENT PERFORMANCE OF ALICE. Bieth, C.; Bourgarel, M. P.; Cabrespine, A.; Gayraud, R.; Attal, P. (Nuclear Physics Inst., Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 93-100(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The ALICE machine consists of a heavy-ion cyclotron and a 1-MeV/amu linac as injector. A PIG ion source of the Morosov type was built for the acceleration of heavy ions by ALICE. The six most important parameters for designing a source for high charge states are discussed. The beam optics and power supplies used with this ion source are described. Results for beam intensity and emittance measurements are given. A current of 0.6 nA of 500-MeV Kr^{24+} on target was achieved for 30 μA at the source. (16 figures, 3 tables) (R.W.R.)

39073 PRODUCTION AND ACCELERATION OF METAL IONS IN THE HARWELL VARIABLE ENERGY CYCLOTRON. Jones, E. J. (Atomic Energy Research Establishment, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 101-4(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The range of ions accelerated by the V.E.C. was recently extended to metal ions. For example, a 5 to 10 μA beam of 48-MeV $^{58}Ni^{6+}$ is now available and has been used by a customer. This beam became possible as a result of success in adapting the normal ion source for the production of metal ions. The problem was to add to the ion source a controlled source of metal vapor without increasing the size of the ion source or adding separate oven heaters and controls. This was achieved by inserting a graphite liner into the existing ion source chimney, the metal being embedded in the liner and out of direct contact with the arc. Provided the arc power exceeds a few kilowatts, the metal becomes molten and the vapor diffuses through the graphite into the arc which then becomes self-sustaining. With nickel (the most widely tested so far), intensity at full radius of between 10 and 20 μA of ions and 1 μA of 8^+ ions is readily obtained; source life averages about 4 hours. Other metals, such as cobalt, iron, chromium, and copper, give similar results. (4 figures, 2 tables) (auth)

39074 SOURCE FOR MULTIPLY-CHARGED IONS AND ACCELERATION OF C, N, AND O IONS BY IPCR CYCLOTRON. Miyazawa, Y.; Kohno, I.; Tonuma, T.; (and others) (Inst. of Physical and Chemical Research, Wako, Japan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 105-8 (Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The design and performance of the ion source which is now used in the IPCR variable energy cyclotron are described. The source is of the electron-bombarded hot cathode type, having two cylindrical cathodes of tungsten and a water-cooled copper anode containing a replaceable molybdenum slit plate. The arc discharge is established continuously but not pulsed. The source is usually operated very stably under an arc power of 1.5 to 3 kW with a gas flow rate of 1 to 2 cc/min. The lifetime of the source is mainly limited by the erosion of the upper tungsten cathode at about 24 hours. At present, C^{4+}, N^{4+}, O^{4+}, N^{5+}, and O^{5+} ions are accelerated up to energies of 48 to 100, 56 to 100, 70 to 95, 56 to 125, and 70 to 125 MeV, respectively; and a few microamperes of these ions are extracted from the cyclotron. The vacuum obtainable in the accelerating chamber is usually 2 to 4×10^{-6} mm Hg, and the loss of ion beam by the charge exchange effect is comparatively small. Extracted ion beams are used in several experiments for about 1900 hours in a year. (7 figures, 1 table) (auth)

39075 PRODUCTION OF MULTIPLY-CHARGED IONS OF Ne, Ar, Kr, AND Xe BY THE ELECTRON-BOMBARDED HOT CATHODE ION SOURCE OF IPCR. Kohno, I.; Miyazawa, Y.; Tonuma, T.; (and others) (Inst. of Physical and Chemical Research, Wako, Japan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 109-13(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Production of multiply-charged ions of Ne, Ar, Kr, and Xe was studied by use of an electron-bombarded hot-cathode type ion source of the IPCR 160-cm cyclotron, which is similar to Morozov's source. These multiply charged ions were accelerated by a 3rd-harmonics acceleration mode in the cyclotron and detected with a beam probe fixed at the radius of 55 cm. Observed multiply charged ions are Ne^{2+}, Ne^{3+}, Ne^{4+}, Ne^{5+}, Ar^{3+}, Ar^{4+}, Ar^{5+}, Ar^{6+}, Ar^{7+}, Ar^{8+}, Kr^{6+}, Kr^{7+}, Kr^{8+}, Kr^{9+}, Xe^{9+}, Xe^{10+}, and Xe^{11+}. Relative abundance of each charge state of four elements was measured. In case of Kr and Xe, the intensity of observed multiply charged ions decreases to ⅓ or ¼ when the charge number is increased by one. Intensities of Ar^{4+}, Ar^{6+}, Ar^{8+}, Kr^{6+}, and Kr^{8+} were measured as a function of the operation conditions of the ion source, such as arc voltage, arc power, and gas flow rate. It was found that a smaller gas flow and a higher arc power brought about a higher yield in all the measured ions. Obtained current intensities of ion source output are 40 μA of Ar^{8+}, 600 μA of Kr^{6+}, 40 μA of Kr^{9+}, 150 μA of Xe^{9+} and 10 μA of Xe^{11+}. (5 figures, 1 table) (auth)

39076 ELECTRON BEAM ION SOURCE AND SOME POSSIBILITIES FOR IMPROVEMENT. Becker, R.; Klein, H.; Schmidt, W. (Univ., Frankfort am Main). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 125-31(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The basic properties of the EBIS as proposed by Donets, such as vacuum requirements, ion yield, and emittance, restrict it in principle to a poor yield of highly charged ions. To overcome this, a concept for a "dynamic containment" is presented. This means that the axial ion movement between first ionization and extraction is delayed in order to give the necessary containment time for CW operation. Realization seems to be possible by partly permeable mirrors, produced by the axial alternating magnetic field of opposing permanent ring magnets, which also provide for electron focusing, considerable reduction of vacuum requirements, and saving of power consumption. (8 figures) (auth)

39077 PROPOSED MULTIPLY CHARGED ION SOURCE. Abdelaziz, Mohamed E.; Morsy, Mohamed W.; Hassan, Zakiah M.; Hanna, Nasser N. (Atomic Energy Establishment, Cairo). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 132-6(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A new type of ion source is proposed which employs a hyperbolic potential field for the dual purpose of trapping the plasma ions and permitting the electrons to impact the trapped ions successively, by which means the ions are rendered highly stripped. The proposed source consists of an axially symmetric hyperbolic Penning assembly energized with fixed and cosinusoidal voltage, and is immersed in a homogeneous axial magnetic field. The anode and both of the two cathodes follow hyperboloidal surfaces of one and two sheets, respectively. Extraction of the stripped ions can be accomplished either radially or axially through an extracting system, which is optimized to satisfy Pierce conditions of rectilinear flow. Filtering the extracted ions is done by a quadrupole mass analyzer. Under the influence of the imposed hyperbolic potential field, electrons are allowed to oscillate with bound or unbound trajectories depending on the operating conditions. From the solutions of the equations of motion governing such oscillating electrons, it is possible to optimize the overall performance of the proposed ion source. (3 figures) (auth)

39078 INHOMOGENEOUS MAGNETIC FIELDS IN MULTI-CHARGED HEAVY ION SOURCES. Hadinger, G.; Tauth, T.; Hadinger-Espi, G.; Bajard, M.; Chabert, A. (Univ., Lyon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 137-41(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A way for studying the ion generation in the plasma of ion sources is described. Results of first calculations give some conclusions about the efficiency of various field patterns. The related experimental program is presented. (9 figures) (auth)

39079 ELECTRON-BOMBARDMENT TYPE SIMPLIFIED SOURCE FOR HIGH TEMPERATURE OPERATING AND THE PRODUCTION OF MULTIPLY-CHARGED IONS UTILIZING BEAM—PLASMA INTERACTIONS. Takagi, T.; Yamada, I.; Ishikawa, J. (Kyoto Univ.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 142-9(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Some properties of an electron-bombardment-type simplified ion source for high-temperature operation to obtain heavy ions are studied. Properties of a two-stage multiply-charged ion source, which is constructed of the simplified ion source and a beam—plasma type ion source, are also studied. In the simplified ion source the magnetic field induced by the filament coil is utilized effectively, so that there is no external magnetic coil. The discharge chamber can be designed to be very small. It is easy to raise the temperature of the discharge chamber higher than 1200°C, and it can be operated stably at high temperatures. It is shown that several metal ions can be obtained easily and sufficiently from materials in solid states at room temperature. A multiply-charged ion source of two stages is then developed. For the first stage the simplified ion source is used to provide singly charged ions for the beam—plasma discharge field. In the second stage the beam—plasma discharge is used to produce multiply charged ions efficiently. A high degree of electron stripping of ions occurs in the presence of energetic electrons of high density generated by beam—plasma discharge due to the beam—plasma interactions. Some properties of this source are studied. (11 figures) (auth)

39080 ION CONTAINMENT SOURCES. Stix, Thomas H. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 150-5(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The environment necessary to create a source of highly stripped ions is described. The only hope for obtaining a reasonable yield of many-times ionized nuclei is by successive ionization. Rather long exposure times of the ions to an energetic electron plasma are required, and electrostatic ion containment appears to be one way these long ion containment times can be achieved. A number of magnetoelectric configurations are described: toroidal and mirror geometries, nonrelativistic and relativistic electron plasmas. Stability calculations for all these devices look quite encouraging. (5 figures) (R.W.R.)

39081 ION TEMPERATURE IN A PLASMA WITH HOT ELECTRONS. Wiesemann, K. (Univ., Marburg, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 156-9(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The ratio between electron temperature and ion temperature in a hot plasma is calculated. The ion lifetime in the plasma is considered to be large as compared to the time required for the energy relaxation between different ion species. Ion confinement is due to an electrostatic potential well resulting from ambipolar diffusion in a trap confining the electrons. The different heating and cooling processes are considered, and it is found that the ion temperature is proportional to the square of the average charge state of the plasma. (2 figures) (auth)

39082 CALCULATED IONIZATION VOLUMES FOR BATCH, CONTINUOUS, AND SELECTIVE EXTRACTION SOURCES OF HEAVY IONS. Darling, R. L.; McShan, D. L.; Davis, R. H. (Florida State Univ., Tallahassee). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 168-71(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Confinement-time and ionization-volume calculations were made for batch, diffusive-continuous, and selective-extraction types of highly ionized, very-heavy-atom ion sources. The results are given for step-by-step only ionization by an energetic electron flux (10^{11} electrons/cm^3 at 10 kV) and for ionization that includes the Auger effect. These are compared for loss conditions that vary from no loss to a loss cross section 0.05 times that of the $0 \rightarrow 1^+$ ionization cross section. For low loss, the ionization volume is least for the selective-extraction source, while for a lossy source the batch process becomes competitive. Volumes for the diffusive-continuous source are the largest in all cases. Introduction of the Auger effect reduces the volumes by a factor of 2 to 10 in all but the diffusive-continuous source. With the assumptions made, the selective-extraction source appears best suited for the low to medium ionization states, while the batch-type source is preferred for the production of exotic ion species, like U^{60+}. (3 figures, 4 tables) (R.W.R.)

39083 LASER SOURCES FOR MULTIPLY-CHARGED HEAVY IONS. Tonon, G. F. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 172-83(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The main results concerning the interaction between lasers and matter are reviewed, with emphasis on the results concerning the state of charge, the energy, and the spatial distribution of the plasma ions. Laser-produced plasmas are proposed as sources of multiply charged ions for heavy-ion accelerators, and the laser characteristics which would be required are defined. (21 figures, 3 tables, 70 references) (auth)

39084 ACCELERATION OF HEAVY IONS FROM A METALLIC PLASMA SUBJECTED TO HIGH ELECTRIC FIELD. Friedman, Moshe (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 184-6(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A focused ruby-laser light pulse with peak power density of $\sim 10^{10}$ W/cm^2 was concentrated on a metallic substance which also acted as an anode. A highly ionized metallic plasma was produced. A few hundred ns later, a positive voltage pulse of 5×10^5 volts for the duration of 50 ns was applied between the anode and a cathode. The cathode was kept at ground potential. A high-current electron beam ($\sim$10kA) was emitted from the cathode and interacted with the plasma, this interaction enhancing its ionization level and temperature. At the same time ions were extracted from the plasma and accelerated. When the anode was made out of Cu, the number of ions accelerated was $\simeq 10^{10}$, and their velocities ranged from 6×10^7 to 6×10^8 cm/s. The number of ions emitted was influenced by the time interval between the laser pulse and the high-voltage pulse. It is suggested that plasma effects may account for the wide energy distribution. A simple theoretical calculation suggests conditions for the decoupling of ions from the metallic plasma and for a scaling law for acceleration of heavy ions with high charge to very high energies. (3 figures) (auth)

39085 NEGATIVE ION SOURCES FOR VARIOUS ELEMENTS. Dawton, R. H. V. M. (Atomic Energy Research Establishment, Harwell, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 231-8(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A brief account is given of the types of ion sources employed for the production of negative ions. The application of these sources to a wide range of elements, grouped mainly by their physical characteristics, is then considered. (8 figures) (auth)

39086 ATOMIC-BEAM ASPECTS OF A COMPACT POLARIZED ION SOURCE. Busch, Charles Edgar. Columbus, Ohio;

Ohio State Univ. (1971). 170p. University Microfilms Order No. 72-15,185.

Thesis.

A compact polarized-particle source was built for use in the pressurized terminal of the Ohio State University 6.0-MeV Van de Graaff Accelerator. The source operates on the atomic-beam principle by using a strong-field sextupole magnet to separate the atoms having electronic spin components of $m_J = \pm\frac{1}{2}$. Transitions are effected between the atomic hyperfine-structure Zeeman levels by using the adiabatic passage technique. The polarized beam is then ionized and injected into the accelerator tube. The theory concerned with the treatment of the atomic beam, particularly that associated with the adiabatic passage transitions, is reviewed. The source was tested external to the 6-MeV accelerator by using the $T(\vec{d},n)^4He$ analyzing reaction at an incident deuteron energy of about 110 keV. A maximum tensor polarization of $p_{zz} = -0.52 \pm 0.05$ was measured during this testing for a deuteron beam intensity of 40 ± 20 nA. The source was installed recently in the terminal of the O.S.U. Accelerator, and a polarized deuteron beam of 10 nA having $p_{zz} = -0.15 \pm 0.04$ was extracted. An indication of some vector polarization was detected; however, technical problems prevented further investigations. (Diss. Abstr. Int., B)

39087 BEAM-DEFOCUSING EFFECT DUE TO FILAMENT MAGNETIC FIELDS IN ELECTRON GUNS OF ELECTRON LINEAR ACCELERATORS. Yamazaki, Hatuo; Ozawa, Yasutomo (Hokkaido Univ., Sapporo). Jap. J. Appl. Phys.; 11: No. 6, 883-8(Jun 1972).

The effect of filament magnetic fields on the emitted electrons is studied theoretically. It is shown that the effect is equivalent to an increase in the emittances of the output beams, and it is not negligible in comparison with the emittances due to thermal motions at the cathodes and those due to the rf fields in the bunching sections of electron linear accelerators. (2 figures) (auth)

39088 PRACTICAL HIGH-β INSERTIONS WITH APPLICATION TO A 1000-GeV SUPERCONDUCTING EXTENSION OF THE EUROPEAN ACCELERATOR. Maidment, J. R.; Planner, C. W. (Rutherford High Energy Lab., Chilton, Eng.). Particle Accel.; 3: No. 3, 175-81(Jun 1972).

In very high energy synchrotrons the final magnet apertures may be determined by the requirements of a high efficiency resonant extraction system. These apertures may be reduced by having an enhanced value of the β-function localized to the first extraction septum position. The effects of enhanced values of β at this position are determined for a 1000-GeV superconducting extension to the European Accelerator. Various methods of obtaining the required β-function are compared and a practical method based on a π-insertion is presented, which could have general application to very high energy accelerators. (auth) (UK)

39089 VERSATILE KLYSTRON BUNCHING SYSTEM FOR A 5.5 MV VAN DE GRAAFF ACCELERATOR. Kritzinger, J. J. (Southern Universities Nuclear Inst., Faure, S. Afr.); McMurray, W. R.; Nuspliger, R. J. Nucl. Instrum. Methods; 101: No. 3, 573-81(1972).

A special version of the ORTEC Klystron bunching system has been installed on the SUNI 5.5 MV Van de Graaff accelerator. The design considerations are outlined. The realization of the full capabilities of this system has been made possible by two modifications: (a) the incorporation of a cross-field analyzer as an integral part of the pulser unit and (b) the installation of a split buncher tube. With the duoplasmatron ion source, continuous current operation was made virtually impossible because of overloading of the accelerator tube by defocused particles of different masses. The cross-field analyzer selects a single mass (or charge) particle for acceleration and thus eliminates this problem. The use of the cross-field analyzer is also required for optimum utilization of the pulsed beam. The incorporation of the analyzer as part of the pulser is described. A buncher tube of fixed length with a bunching voltage of fixed frequency is only optimum for one particle mass. A modified buncher tube is shown to give superior performance for mass 1 to mass 3 beams for which pulses of 1 to 1.5 ns width (fwhm) respectively, have been obtained. Using the original buncher tube the best result achieved with mass 3 beams was 2.6 ns. Effective bunching factors greater than 20 have been achieved with an average current of about 5 μA on the target at a pulse rate of 2 MHz. The energy spread in the bunched proton beam is about 4 keV. The SUNI system is designed to switch readily from continuous to pulsemode operation with protons, deuterons or helium ions. (auth)

39090 CHARACTERISTICS OF STRIPPING NEON IONS WITH CARBON FOILS. Thornton, S. T.; McKnight, R. H.; Ritter, R. C. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods; 101: No. 3, 607-9(1972).

The foil lifetimes, charge state distributions and beam scattering have been measured for the bombardment of 20 μg/cm^2 carbon foils by 2 and 4 MeV Ne^+ ions. The charge state distributions and beam scattering agree with previous results. Foil lifetimes of about an hour were obtained. (auth)

39091 STUDY OF THE LOCATION OF THE FORMATION OF THE IONS IN A PENNING ION SOURCE AS A FUNCTION OF THE SHAPE OF THE MAGNETIC FIELD BY THE MONTE CARLO METHOD. Hadinger, G. (Univ. Claude Bernard, Lyon. Institut National de Physique Nucleaire, Villeurbanne, France); Hadinger-Espi, G.; Tauth, T.; Illgen, J.; Jacoby, W. Nucl. Instrum. Methods; 102: No. 1, 157-165(1972). (In French).

A way of studying the elementary processes of the plasma arc discharge is described. This makes it possible to point out the location of the formation of multi-charged ions. This method was applied to a source PIG in an inhomogeneous field. With the first results it is hoped that it will be possible to determine a configuration of an optimum field. (auth)

Ion Optics and Field Calculations

Refer also to abstract 39097.

39092 SYSTEM OF QUADRUPOLAR ELECTROSTATIC MICRO-LENSES. Guernet, Georges (to Commissariat a l'-Energie Atomique). French Patent 2,076,567. 20 Sep 1971. Filed 20 Jan 1970. (In French).

A system of quadrupolar electrostatic micro-lenses (an assembly of very small electrostatic lenses each having four electric poles) is described. This system enables a system of small cross section, mutually parallel and convergent micro-beams to be obtained simultaneously from a beam of charged particles having a large cross section. (France)

39093 TRANSIENTS WHICH ACCOMPANY THE INJECTION OF DENSE ELECTRON BEAMS INTO A COMPRESSOR. Globenko, Yu. G. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1302-6 (Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 38-42(Sep-Oct 1971).

The injection of dense electron beams into a compressor is accompanied by transients which lead to a broadening of the beam during one revolution. Three possible processes are considered. The first two are associated with Coulomb interaction of the particles with the beam and the effect of the beam image in the chamber wall on the beam. The third process is caused by coherent synchrotron radiation from the front of the beam which gradually fills the equilibrium orbit in the compressor. It is shown that the first two processes are substantial at high densities and excite coherent betatron oscillations of the beam. The third process is associated with energy losses from the front of the beam; this loss may be considerable even for densities which are not very high, and likewise leads to excitation of coherent betatron oscillations. (1 figure, 1 table) (auth)

39094 SHAPING OF AN INTENSE ELECTRON BEAM IN A MAGNETIC FIELD. Kudelainen, V. I.; Meshkov, I. N.; Salimov, R. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1821-3(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2294-6(Nov 1971).

A method is described for shaping an electron beam in a gun immersed in a longitudinal magnetic field. A three-anode structure extends the region of falloff of the accelerating field to a length equal to the pitch of the cyclotron rotation helix. Particles leave the gun without acquiring any further transverse velocity close to the anode. Experiments illustrating the effectiveness of the method are described. (auth)

Storage Rings

Refer also to abstract 39693.

39095 (BNL-16787) SOME SIX BLOCK COIL CONFIGURATIONS FOR A COSINE BENDING MAGNET. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). 26 Apr 1972. 2p. Dep. NTIS.

When the cosine winding in a bending magnet is arranged in six blocks in a Beth configuration, differences in the percent good field aperture are obtained depending on the ribbon distribution used. Results are presented for three different ribbon distributions which give percent good field apertures that vary from 62 to 71%. (1 table) (R.W.R.)

39096 (BNL–16790) PRELIMINARY BASIC PARAMETERS, PROTON STORAGE RING PROJECT. Blewett, J. P.; Chasman, R. W.; Courant, E. D.; Mills, F. E.; Month, M.; van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). 14 Jul 1971. 17p. Dep. NTIS.

The general design parameters, orbit parameters, and beam transfer parameters for the proposed ISABELLE storage rings at BNL are listed. Also, the crossing angle at experimental intersections and luminosity values are briefly discussed. (W.H.K.)

39097 (BNL–16799) ELECTRON COOLING OF PROTONS IN ISABELLE. Gluckstern, R. L. (Brookhaven National Lab., Upton, N. Y.). 23 Aug 1971. 9p. Dep. NTIS.

Following Budker, the rate of damping of the transverse emittance of a circulating proton beam by means of Coulomb collisions with a high quality beam of electrons traveling with the protons (electron cooling) is derived. Electron cooling is studied in an effort to increase the luminosity in the AGS intersecting proton storage ring ISABELLE which is in the preliminary design stage. It was found that damping is most efficient at low energies, and the damping rates are estimated at 30 GeV in the storage ring and at 1 GeV and 200 MeV in the AGS. Results and conclusions are presented. (W.H.K.)

39098 EFFECTS OF MATCHED INSERTIONS IN LOW PERIODICITY LATTICES. Month, M. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 3: No. 3, 183-8(Jun 1972).

Effects of low periodicity insertions are considered. The insertions are assumed to have the basic properties suitable for particle experiments in storage rings. They are also assumed to be matched to the main lattice cells with respect to both betatron and momentum dispersion variables at a specific tune and momentum. For a momentum error, however, the tune is shifted and the matching is broken. This mismatching introduces instabilities at tunes directly related to the periodicity of the insertions, N. Gradient instabilities occur at all values of the tune given by $\nu \sim N/2 \times$ integer, while dipole resonances occur at $\nu \sim N \times$ integer. Expressions characterizing these instabilities are derived. Specifically, for gradient instabilities, the growth in the β function and the available momentum aperture near the resonances are estimated. The use of sextupoles as correction devices, for reducing the β growth and opening the momentum aperture, is discussed. An idealized lattice with two-fold symmetry is treated as an example. (auth) (UK)

Experimental Facilities

Refer also to abstracts 38530, 39551, and 39693.

39099 (AERE-R–6626) PRELIMINARY EXPERIMENTS WITH AN EVAPORATION NEUTRON SOURCE ON THE VARIABLE ENERGY CYCLOTRON DESIGNED TO SIMULATE FAST REACTOR SPECTRA. Boot, S. J.; Cuninghame, J. G.; Dennis, J. A.; Willis, H. H. (Atomic Energy Research Establishment, Harwell (England)). May 1972. 9p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

A neutron source was constructed for the Harwell Variable Energy Cyclotron which provides a neutron spectrum very similar to that of the DFR fast reactor core center. The flux available is sufficient for the performance of on-line fission fragment experiments (if the high cost, mostly running cost of the cyclotron, can be justified). The source provides a fast flux of $\sim 2 \times 10^9$ n/cm^2/sec which, though about a factor of 5 lower than that available at the electron linac/neutron-booster, is suitable for radiochemical irradiation experiments. Useful information concerning the efficiency of various shielding materials for fast neutrons was also obtained. (auth) (UK)

39100 (BNL–16759) BURNING AND PROPAGATION OF FLAME IN CABLE TRAYS AT THE AGS. Plotkin, M. (Brookhaven National Lab., Upton, N. Y.). 18 Apr 1972. 51p. Dep. NTIS.

The experimental facilities at the AGS utilize many miles of cable trays arranged in multiple vertical tiers around each building. The trays are filled with various types of control, signal, and power cables. This investigation was carried out to determine the potential for cable burning and flame propagation in these trays. Various cable manufacturers were contacted and visited and a number of tests were performed at BNL. The BNL tests simulated, in many cases, the exact configurations which exist in the installation. On the whole, the cables and configurations used at the AGS do not present a fire hazard. (auth)

39101 (BNL–16805) MEASUREMENT OF SINGLE PARTICLE SPECTRA AT ISABELLE. Good, M. L. (Brookhaven National Lab., Upton, N. Y.). Aug 1971. 5p. Dep. NTIS.

A detector setup for spectra measurements of $\pi^{\pm}$, $K^{\pm}$, and $p^{\pm}$ from colliding beam p + p interactions at ISABELLE is briefly described. (W.H.K.)

39102 (COO–2146-2) PROGRAM IN MEDIUM ENERGY NUCLEAR PHYSICS RESEARCH. (NUCLEON–NUCLEON POLARIZATION CORRELATION EXPERIMENTS IN THE 300 TO 800 MeV RANGE. Technical Progress Report, September 1, 1971–August 31, 1972. Willard, H. B. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). 23 May 1972. Contract AT(11-1)-2146. 6p. Dep. NTIS.

The status of the design and construction of the equipment for beam handling, targets, detectors, and data acquisition for the N + N polarization correlation experiments at LAMPF is outlined. Progress on the multiwire proportional counters, the data acquisition computer, the beam profile monitor, the Faraday cup, and the computer programs is briefly described. (W.H.K.)

39103 (EUR–4404(Pt.2)) IBM 1800 PROGRAMS FOR DATA PROCESSING AT THE ACCELERATORS OF THE CENTRAL BUREAU FOR NUCLEAR MEASUREMENTS. PART 2. INTERRUPT SERVICING PROGRAMS FOR DATA HANDLING AND REDUCTION. Horstmann, H.; Colling, F. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 2 Feb 1972. 182p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 250.-.

A set of interrupt servicing programs for data transfers from a number of data acquisition stations at a Van de Graaff and an electron linear accelerator to an IBM 1800 computer is described. Also, a description of several test routines which can be used to check the functional characteristics of the interface units connecting the data acquisition stations to the computer is given. The data acquisition stations are equipped with fast time-of-flight multi-channel analyzers, and the source of most of the data to be collected and transferred to the computer are neutron cross section experiments. Besides controlling the data transfers between the analyzers and the disk storage of the computer, several programs also perform data reduction procedures, especially for total cross section measurements. All programs are written in ASSEMBLER language for the Time-Sharing Executive System (TSX). (auth)

39104 (LA-DC–72-611) SPECTRUM OF NEUTRONS PRODUCED BY 800-MeV PROTONS ON URANIUM. Veeser, L. R.; Fullwood, R. R.; Shunk, E. R.; Robba, A. A. (Los Alamos Scientific Lab., N. Mex.). 1971. 10p. (CONF-720607–18). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

The neutron spectra from 740-MeV protons bombarding a 30-cm-thick, depleted uranium target were measured from 60 keV to 10 MeV at angles of 50 and 130° with respect to the proton beam. Measurements were made at the 184-in. cyclotron, Lawrence Berkeley Laboratory (LBL). A 5 cm by 5 cm organic liquid scintillator and two hydrogen-filled spherical proportional counters were used to cover overlapping energy regions in making the measurements. The data were obtained from the detector yields by unfolding the known responses to monoenergetic neutrons. The results are compared with Monte Carlo calculations of the neutron cascade-evaporation spectrum for 800-MeV protons hitting a similar uranium target. The calculations were made with the code NMTC. (auth)

39105 (LA-tr–72-11) AUTOMATING A LABORATORY OF NUCLEAR PHYSICS BY COMPUTER. I. CONCEPTION AND PROGRAMMING. Bluet, J. C.; Fardeau, P.; Leroy, J. L.; Paternot, Y.; Viers, M. Translated for Los Alamos Scientific Lab., N. Mex., from Nucl. Instrum. Methods; 93: 35-44(1971). 27p. Dep. NTIS.

An on line-computer is used to operate automatically a 5 MeV Van de Graaff accelerator and the associated experimental apparatus. The main parameters to be adjusted are the accelerator energy, the positions of sample and detectors, and the field of an electromagnetic analyzer. Usually data acquisition is made on multichannel analyzers of scalers used as intermediate memories. At the end of each run the primary data is transferred into the computer for data reduction and editing. Each specific action of the computer on an external device is made by means of a subroutine written in machine language. All these subprograms can be called by the main program, written in FORTRAN. This program also does data reduction during data acquisition of the following run. (auth)

39106 METHOD OF PRODUCING NEUTRONS, EQUIPMENT UTILIZING THE METHOD. Debiesse, Jean; Klein, Siegfried (to Commissariat a l'Energie Atomique). French Patent 2,070,526. 16 Aug 1971. Filed 8 Dec 1969. (In French).

A method of producing neutrons is described. The method involves continuously circulating a deuterated or tritiated vapor in a target, in which it is bombarded by deuterons. (France)

39107 ROTATING TARGET FOR AN ELECTROSTATIC ACCELERATOR OPERATING AS A NEUTRON GENERATOR. Roche, Michel (to Commissariat a l'Energie Atomique). French Patent 2,076,568. 20 Sep 1971. Filed 20 Jan 1970. (In French).

A rotating target for an electrostatic accelerator operating as a neutron generator is presented. The target has a general annular form and is supported by a rotor within which the accelerator beam penetrates. The rotor consists of a shaft supported on bearings and rotated by a convenient means. A stator is provided around the rotor forming a backing device behind the target. The circulation of a coolant in the space between the backing device and the target is envisaged, the circulation of the fluid being caused by the rotation of the rotor acting as a pump on the fluid. The system possesses a temperature exchanger and at least one assembly of blades between the rotor and stator. (France)

39108 STIGMATIC AND ACHROMATIC SYSTEM FOR TRANSPORTING A PARTICLE BEAM: ACCELERATORS USING THE SYSTEM. Aucouturier, Jeanne (to Thomson-CSF). French Patent 2,076,690. 20 Sep 1971. Filed 23 Jan 1970. (In French).

A plane, magnetic stigmatic, and achromatic device for transporting a beam of particles (electron beam) is presented. This device guides and focuses a particle beam and enables a beam, which is rectilinear at the entrance, to be transformed into a beam, which is rectilinear at the exit, the position and direction of the beam being independent of the particle energy. The device utilizes 4 electromagnets situated in pairs about a center of symmetry contained in the plane of deviation. The pole pieces fix the gaps between which the beam passes, the magnetic fields created in these gaps being in the same direction in alternating senses. A particle accelerator and an industrial gammagraphy apparatus utilizing this sort of device are described. (France)

39109 THREE-METER LIQUID-HYDROGEN TARGET. Golovanov, L. B.; Mazarskii, V. L.; Tsvinev, A. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1310-13(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 45-8(Sep-Oct 1971).

The construction of a 3-m liquid-hydrogen target with a nitrogen shield is described. The diameter of the target windows is 120 mm. The windows are made of Dacron. The volume of the inner vessel is 140 liters, and the volume of the vessel containing the nitrogen (the shield) is 50 liters. The continuous operating time of the target without refilling with nitrogen is 100 h. The scheme used to monitor the evaporation by means of thermocouples is presented. (3 figures) (auth)

39110 LIQUID-HYDROGEN CONICAL TARGET. Borzunov, Yu. T.; Golovanov, L. B.; Mazarskii, V. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 5, 1314-16(Sep-Oct 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 5, 48-50(Sep-Oct 1971).

The construction of a liquid-hydrogen conical target with a large output aperture is described. The target windows are thin-walled at the entrance and have a diameter of 100 mm, while at the exit they have the dimensions 372 × 140 mm^2. The length of the inner vessel of the target is 250 mm, and its capacity is 13.6 liters. (2 figures) (auth)

39111 REACTION CHAMBER FOR ISOMERIC FISSION MEASUREMENTS. Feldl, E. J.; Leachman, R. B. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods; 101: No. 3, 563-5 (1972).

A reaction chamber has been designed and constructed to allow measurements of the fission modes from isomers having about 10^{-2} half life. Fission modes are obtained from coincident measurement of the energies of fragment pairs from each isomeric fission. Mechanical chopper-shutter arrangements were utilized to shield the detectors from prompt fissions during the deuteron bombardment of the target and alternatively to block the deuteron beam while the detectors were exposed to the fission source. (auth)

39112 MICROTRON AS A NEUTRON SOURCE FOR ACTIVATION ANALYSIS. Brovtsyn, V. K.; Samosyuk, V. N.; Tsipenyuk, Yu. M. At. Energ. (USSR); 32: No. 5, 383-8(May 1972). (In Russian).

An experimental study on a microtron of the properties of lead and beryllium photoneutron converters is reported. The spatial distributions of fast and slow neutrons, bremsstrahlung, absolute integral yields, and neutron fluxes at electron energies of 13 and 29 MeV were measured. The threshold sensitivities of the neutron activation analysis for a number of elements were determined. (5 figures, 1 table) (auth)

39113 GENERATOR FOR PRODUCING MONOENERGETIC, HIGH INTENSITY, SOFT X-RAYS. Gaines, J. L. (Univ. of California, Livermore). Nucl. Instrum. Methods; 102: No. 1, 7-12(1972).

An x-ray generator for producing monoenergetic high-intensity x-ray beams in the energy range of 1.5 to 8 keV has been developed. Electrons from an annular-shaped triode electron gun bombard one of nine individual water-cooled targets, which can be rotated into the electron beam. With appropriate filtration, each target provides a very intense source of fairly monochromatic x-rays. The electron gun can be operated either in a steady state or in a modulated mode, and the resulting x-ray beam intensity and energy can be measured accurately. (auth)

39114 DESIGN OF A TAGGED PHOTON—ELECTRON BEAM FACILITY FOR NAL. Halliwell, C. (Carleton Univ., Ottawa); Biggs, P. J.; Busza, W.; (and others). Nucl. Instrum. Methods; 102: No. 1, 51-9(1972).

A design for a tagged photon—electron facility for the National Accelerator Laboratory is presented. This facility is designed to provide tagged photons with energy from 15 to 300 GeV and electrons up to 300 GeV with energy resolution of ±≈2.0%. For 10^{13} incident 500 GeV protons we expect typically 1.5×10^8 electrons at 150 GeV and 5×10^5 photons with $100\ \text{GeV} < E < 150\ \text{GeV}$. Photons from π^0's produced in a primary target by proton interactions are separated from charged secondaries and then allowed to convert to e^+e^- in a Pb radiator. The electrons are transported either to an experimental target or to a second radiator where they may produce photons with tagged energy. Hadronic contamination is kept below a few tenths of a percent. (auth)

39115 HIGH DENSITY WINDOWLESS GAS TARGET. Ulbricht, J.; Clausnitzer, G.; Graw, G. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 102: No. 1, 93-9(1972).

High pressure gas is allowed to expand freely into the vacuum, where a supersonic beam is formed. After a critical distance the beam is caught again in an appropriately cone-shaped tube, which offers the following advantages: the beam acts as a pump for the open region between the nozzle and the cone due to momentum transfer to the surrounding gas particles; a back pressure of more than one atmosphere can be tolerated because of the high momentum of the beam. These properties allow the construction of a high density windowless gas target with a considerable reduction of the gas load. A density between 10^{20} and 10^{21} particle/cm^3 was reached in a 2 mm diameter nitrogen beam. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 39566, 39625, 39927, 39973, and 40050.

39116 (AECL–4161) COSMIC RAY NM-64 NEUTRON MONITOR DATA FROM KULA, HAWAII AND MONTHLY GRAPHS, JANUARY–DECEMBER 1971. Steljes, J. F.; Kowalski, A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Apr 1972. 43p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

Uncorrected and barometer-corrected hourly data from a 3-NM-64 mobile latitude survey neutron monitor stationed at Kula, Maui, Hawaii, are given in tabular form for the period from January 1971 to December 1971. Correction factors for the drift of the barometer have been determined. Graphs of the corrected data are given. (auth)

39117 CONTRIBUTION TO THE BACKGROUND RATE OF A SATELLITE X-RAY DETECTOR BY SPALLATION PRODUCTS IN A CESIUM IODIDE CRYSTAL. Dyer, C. S.; Morfill, G. E. (Imperial Coll. of Science and Tech., London). Astrophys. Space Sci.; 14: No. 1, 243-58(Nov 1971).

The energy spectra observed in a CsI crystal in the 20-keV to 2-MeV range, due to the decay of radioactive isotopes produced in the crystal by bombardment with 155-MeV protons, are presented as a function of time after irradiation. It is shown that the large number of decay products produced by spallation can account for these spectra and that these spectra are in quantitative agreement with the predictions of a semi-empirical formula due to Rudstam, which gives the numbers of different isotopes produced. This formula is used to predict the spallation that would occur in such a crystal on board a satellite due to cosmic rays and passages through the South Atlantic Anomaly. Inspection shows that the spallation produced in the latter case is well approximated by that at 155 MeV. Hence the experimental results are used to explain previously observed background rates and to predict the background rates that would occur in the U.K.5 x-ray telescope of Imperial College. Using the Rudstam formula an estimate of cosmic ray induced background is also made. The relative importance of activity resulting from neutron interactions (atmospheric albedo and spacecraft secondaries) is considered. It is suggested that the Rudstam formula provides a general method of predicting induced radioactivity in satellite materials and that observed breaks in the diffuse cosmic x-ray spectrum could be due to inadequate allowance for this source of background. (auth)

39118 EXTRAGALACTIC COSMIC RAYS. Brecher, K.; Burbidge, G. R. (Univ. of California, San Diego). Astrophys. J.; 174: No. 2, 253-91(1 Jun 1972).

A detailed analysis is given of the possibility that a large part of the primary cosmic-ray flux is of extragalactic origin. Problems encountered in theories of galactic cosmic rays are discussed. The possibility that the bulk of the locally observed cosmic-ray energy contained in the protons with $E_p \geq 10^9$ eV originates outside the Galaxy is examined. The objections that have previously been raised to extragalactic theories, particularly on energetic grounds, are discussed and it is shown that there are no major problems, but still many uncertainties. The general problem of the propagation of cosmic rays which are ejected from galactic nuclei or in galactic winds to fill clusters and superclusters is considered. The limits which are set on the presence of extragalactic cosmic rays by observations of high-energy electrons and background x rays and γ rays, or the heating of a hypothetical intergalactic gas, are discussed. Observable effects of cosmic rays between galaxies are considered. The possible sources of the local cosmic-ray protons in the extragalactic model are examined. It is shown that the observed limits on isotropy of cosmic-ray protons can be understood in a model in which they have an extragalactic origin and spend only a short time ($\sim 10^6$ years) in the galactic disk. (94 references) (W.D.M.)

39119 RESOLUTION OF A PARADOX IN KINEMATIC TURBULENCE THEORY. Lerche, I. (Univ. of Chicago). Astrophys. J.; 174: No. 2, 309-19(1 Jun 1972).

Using the thermal conduction of heat in an infinite, incompressible fluid possessing a turbulent velocity field as an illustration, it is shown that the existence of growing modes of a system is by no means a guarantee that the system at hand is unstable. It is shown that for the problem such growing modes are mathematically correct but physically absurd, giving rise, therefore, to a paradox. They are eliminated in an illustrative problem by the requirement of physical causality which therefore resolves the paradox. Based on the results obtained from the illustrative problem guidelines are set up which must be applied to every physical problem involving random-function theory to determine which of the mathematically obtained modes are physically permissible. The only sure way for selecting the physically relevant modes is contained in a statement of physical causality. (auth)

39120 TOKYO LARGE AIR SHOWER EVENT. Garmston, H. J.; Watson, A. A. (Univ. of Leeds, Eng.). Nature (London) Phys. Sci.; 237: No. 72, 39-41(15 May 1972).

The data of a very large air shower recorded by the Tokyo Air Shower Group at the Institute for Nuclear Studies are critically examined. It is shown that an energy in the range $4 \times 10^{19} < E_p < 1.4 \times 10^{20}$ eV is consistent with the data. (auth)

39121 CHERENKOV LIGHT IN (10^{11} TO 10^{12}) eV EAS: TIME DEPENDENCE OF THE ISOPHOTES AND MULTIPLE PULSES. Castagnoli, C. (CNR, Turin. Univ., Turin); Picchi, P.; Locci, M. A. Nuovo Cim.; 9B: No. 2, 213-21(11 Jun 1972).

The radial and time dependence of the isophote diagrams for the Čerenkov light in (10^{11} to 10^{12})-eV EAS was calculated with a Monte Carlo method. A possible explanation for the Čerenkov pulse structure (rise time and width) observed with fast techniques is given. (auth)

39122 ANALYSIS OF GEOMETRY EFFECTS IN THE DETECTION OF CHERENKOV LIGHT FROM EXTENSIVE AIR SHOWERS. Bosia, G.; Maringelli, M.; Navarra, G. (CNR, Turin. Univ., Turin). Nuovo Cim.; 9B: No. 2, 201-12(11 Jun 1972).

The various geometrical effects that contribute to shaping the CL pulse from EAS are investigated on the basis of the electromagnetic model of cascade. It is shown that the "age" of the shower should produce measurable modifications of the pulse shape. This suggests a new approach to the analysis of the EAS development. (auth)

39123 EFFECT OF TYPE II FLUCTUATIONS ON THE DEVELOPMENT OF EXTENSIVE AIR SHOWERS. Dupuy, Jean (Univ., Pau, France); Cachon, Andre; Capdevielle, J. N. Compt. Rend., Ser. B; 274: No. 8, 570-3(21 Feb 1972). (In French).

An exceptionally high inelasticity in the initial proton–nucleus interaction may involve abnormally high relative muon abundances at sea (behaving as if the resulting extensive air shower had been generated by a heavy nucleus). The confusion between the two possible primary corpuscles can be avoided by considering two criteria: a criterion concerning the lateral electron distribution and a criterion concerning the relative hadron–muon abundance. (France)

39124 INTERPRETATION OF MUON RICH SHOWERS, TAKING TYPE I AND TYPE II FLUCTUATIONS INTO CONSIDERATION. Cachon, Andre (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France); Capdevielle, J. N.; Dupuy, Jean. Compt. Rend., Ser. B; 274: No. 9, 665-8(28 Feb 1972). (In French).

The average characteristics of very-high-energy nuclear interactions (10^{13} to 10^{20} eV) can be obtained from the average properties obtained from statistical analysis of a large number of showers, neglecting Type-II fluctuations. In the case of muon-rich showers, individual investigations of extensive showers, using the criteria suggested, can be used to evaluate inelasticity fluctuations and nuclear interaction cross sections and to identify primary corpuscles (nucleon or nucleus). (France)

39125 STUDY OF THE EMISSION SPECTRA OF WR STARS. I. STRUCTURE OF THE SPECTRA OF C III, N IV, AND O V RELATED TO THE UPPER EXCITATION CONFIGURATIONS 2pn, pd. Nikitin, A.; Feklistova, T. (Leningrad State Univ. Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat Mat.; 21: No. 1, 31-40(1972). (In Russian).

The applicability of the one-configuration approximation and the LS scheme for ions of the isoelectronic sequence C III, N IV and O V is discussed. It is shown that, in general, the LS scheme and the one-configuration approximation hold reasonably well for all the 2pn, pd configurations, and the agreement between theory and observations becomes better while passing from C III to N IV and O V. The upper excitation states of the configurations of the ions studied are found by the half-empirical method. The estimates of the energy levels and wavelengths of some lines corresponding to the transitions between the high-excitation levels obtained are given. (auth)

Stars

Refer also to abstracts 39236, 39319, and 39658.

39126 COLLISIONAL PROCESSES IN STELLAR SYSTEMS. Gilbert, Ira H. (Brandeis Univ., Waltham, Mass.). Astrophys. Space Sci.; 14: No. 1, 3-10(Nov 1971).

The theory of collisional relaxation in stellar systems is discussed in terms of an expansion in powers of 1/N, the inverse of the total number of stars. The results are expressed in terms of the concept of gravitational polarization. (auth)

39127 CERTAIN DISCONTINUOUS MARKOV PROCESS IN STELLAR DYNAMICS. Tscharnuter, Werner (Inst. of Theoretical Astronomy, Vienna). Astrophys. Space Sci.; 14: No. 1, 11-14(Nov 1971).

It is shown that Chandrasekhar's basic assumption is more general than the choice of a diffusion process. If the stochastic variations in velocity space are approximately describable as a Markov process, the question arises whether it is uniquely determined by the properties of the fluctuating part of the gravitational field and whether the jump phenomena can be explained by an analysis of its sample paths alone without employing additional assumptions. (W.D.M.)

39128 NUMERICAL EXPERIMENTS ON THE N-BODY PROBLEM. Aarseth, S. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Space Sci.; 14: No. 1, 20-34 (Nov 1971).

The different types of numerical methods available for integrating the equations of motion of N-body systems are discussed. It is desirable to supplement ordinary integration schemes with special treatments of close encounters using a two-body perturbation description or introducing regularizing transformations of the coordinates and time. Direct methods are at present limited to the study of a few hundred particles but larger systems may be investigated using Monte Carlo techniques or the Boltzmann moment equations. N-body computations were performed for a whole range of initial conditions and the general results are summarized. Numerical investigations have already clarified a number of important aspects of cluster evolution and the qualitative behavior of small stellar systems is now quite well understood. Recent theoretical modifications have reduced the disagreement with experiments but further improvements are still needed. (auth)

39129 MULTI-PARTICLE REGULARISATION TECHNIQUE. Heggie, D. C. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Space Sci.; 14: No. 1, 35-9(Nov 1971).

Certain features of a practical regularization method, in which the potential or kinetic energy is used as a time-regularizing function, are described. For two-body encounters the method is less powerful than Kustaanheimo–Stiefel regularization, but it has wider applicability. (auth)

39130 USE OF INTEGRALS IN NUMERICAL INTEGRATIONS OF THE N-BODY PROBLEM. Nacozy, Paul E. (Univ. of Texas, Austin). Astrophys. Space Sci.; 14: No. 1, 40-51(Nov 1971).

The numerical integration of systems of differential equations that possess integrals is often approached by using the integrals to reduce the number of degrees of freedom or by using the integrals as a partial check on the resulting solution, retaining the original number of degrees of freedom. Another use of the integrals is presented here. If the integrals have not been used to reduce the system, the solution of a numerical integration may be constrained to remain on the integral surfaces by a method that applies corrections to the solution at each integration step. The corrections are determined by using linearized forms of the integrals in a least-squares procedure. The results of an application of the method to numerical integrations of a gravitational system of 25-bodies are given. It is shown that by using the method to satisfy exactly the integrals of energy, angular momentum, and center of mass, a solution is obtained that is more accurate while using less time of calculation than if the integrals are not satisfied exactly. The relative accuracy is ascertained by forward and backward integrations of both the corrected and uncorrected solutions and by comparison with more accurate integrations using reduced step-sizes. (auth)

39131 MONTE CARLO METHOD. Henon, M. (Observatoire, Nice). Astrophys. Space Sci.; 14: No. 1, 151-67(Nov 1971).

A detailed technical description is given of a Monte Carlo scheme for the dynamical evolution of spherical stellar systems. (auth)

39132 COMBINED OPERATIONAL METHOD FOR TRANSFER PROBLEMS IN HOMOGENEOUS, SPHERICAL MEDIA. Kho, T. H.; Sen, K. K. (Univ. of Singapore). Astrophys. Space Sci.; 14: No. 1, 223-42(Nov 1971).

The combined operational method developed by Busbridge (1961) in connection with the radiative transfer problems in plane-parallel atmospheres is extended to similar problems in isotropic scattering, homogeneous spherical media. The relevant auxiliary equation is formulated, the scattering function defined, and the integro–differential equation for such function deduced. For a medium having radial distribution of source in addition to the incident flux at the outer surface, the integro–differential equations for source function and emergent intensity are established. (auth)

39133 SECOND CATALOG OF EMISSION-LINE STARS OF THE ORION POPULATION. Herbig, G. H.; Rao, N. Kameswara (Univ. of California, Santa Cruz). Astrophys. J.; 174: No. 2, 401-23(1 Jun 1972).

The catalog contains 323 emission-line stars of the Orion population that have been observed with slit spectrographs. Accurate positions are given for most objects, together with UBV data where available, spectral classification, emission-line intensity class, type of star, light range and classification of the light curve, nebula with which the star is associated, and remark or indication when the star is nebulous or double. The catalog is based upon all published information available to mid-1971, together with unpublished Lick data. (auth)

39134 EFFECTS OF RECENT OPACITY CORRECTIONS ON A MAIN-SEQUENCE STELLAR MODEL OF 2.25 $M_\odot$. Novotny, Eva (Univ. of Pennsylvania, Philadelphia. Manned Spacecraft Center, Houston, Tex.). Astrophys. J.; 174: No. 2, 425-34(1 Jun 1972).

A comparison was made between models calculated with the opacities of Carson, Mayers, and Stibbs and the electron-scattering corrections of Watson with models based on the opacities of Cox, Stewart, and Eilers. The models had a mass of 2.25 $M_\odot$ and a chemical composition with $X = 0.596$ and $Z = 0.02$. With the adopted formulae representing the new opacities, it was found that the percentage changes with respect to the model based on the opacities of Cox et al. can be as large as +11 for the stellar radius, −42 for the luminosity, −15 for the effective temperature, −30 for the mass of the convective core, −8 for the central pressure, and −4 for both the central density and the central temperature. (auth)

39135 ANALYSIS OF THE MAGNETIC FIELD OF 53 CAMELOPARDALIS AND ITS IMPLICATIONS FOR THE DECENTERED-DIPOLE ROTATOR MODEL. Huchra, John (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 174: No. 2, 435-8(1 Jun 1972).

The mean surface field of 53 Cam was estimated by measurement of resolved Zeeman splittings, where possible, and by use of a relation between observed line width and Zeeman pattern to estimate the field strength when the splittings are not resolved. A fit was then made to the decentered-dipole rotator model giving $a = 0.145$, $\beta = 80°$, $i = 50°$, $H_p = -28.4$ kilogauss. An attempt to fit the shapes of the curve with the model led to unsatisfactory results. Landstreet's (1970) parameters for this star reproduce the H_e variations well, but lead to incorrect results for the H_s variations. (auth)

39136 EXPERIMENTAL INVESTIGATION OF THE $^{16}O + ^{16}O$ TOTAL REACTION CROSS-SECTION AT ASTROPHYSICAL ENERGIES. Spinka, H. (California Inst. of Tech., Pasadena); Winkler, H. Astrophys. J.; 174: No. 2, 455-61(1 Jun 1972).

Results are presented for the $^{16}O + ^{16}O$ total reaction cross-section measured between $E_{cm} = 6.8$ and 11.85 MeV, near the region of astrophysical interest. Many exit channels were investigated by using a number of different experimental techniques, and cross-sections for these exit channels are given. The large number of energetically accessible excited states in the heavy reaction products and three-body exit channels made the determination of the total reaction cross-section difficult. The total reaction cross-section was found to be a smooth function of the $^{16}O + ^{16}O$ energy, in contrast to the behavior of $^{12}C + ^{12}C$ and $^{12}C + ^{16}O$. (auth)

39137 PRODUCTION OF IONIZING ULTRAVIOLET RADIATION BY SUPERNOVA EJECTA. Colgate, Stirling A. (New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J.; 174: No. 2, 377-82(1 Jun 1972).

There exist significant difficulties with the efficient (≥50%) production of hydrogen-ionizing or helium-fluorescing ultraviolet radiation by supernovae. Since the observed visible radiation is a small fraction (10^{-3}) of the ultraviolet energy required for the previously proposed production of either the Gum Nebula or optical emission by helium fluorescence, the emission temperature must be high. The kinetic energy of supernova ejecta is the presumed source of the necessary heating. In the case of blackbody emission the constraints of high temperature and high efficiency result in an unrealistic requirement of the collision between ultrathin shells. In the limit of transparent emission, a significant fraction of the emitted photons are either too low in energy to ionize hydrogen or too high in energy either to ionize efficiently or to be absorbed. (auth)

39138 STELLAR WINDS AND BREEZES. Roberts, P. H. (National Center for Atmospheric Research, Boulder, Colo.); Soward, A. M. Proc. Roy. Soc. (London). Ser. A; 328: No. 1573, 185-215(23 May 1972).

Steady stellar winds are generally divided into two classes: (i) the winds proper, for which the energy flux per unit solid angle, E_∞, is nonzero, and (ii) the breezes, for which $E_\infty = 0$. The breezes may be distinguished from one another by the value of the ratio, g, of kinetic to thermal energy of the particles in the limit of large distance, r, from the stellar centre, or more precisely by $g = \lim_{r\to\infty}(mv^2/kT)$, where v(r) is breeze velocity, T(r) is temperature, m is mean particle mass, and k is the Boltzmann constant. It is demonstrated that two distinct solutions exist as $g \to 5/3$, namely the $g = 5/3-$ and the $g = 5/3+$ possibilities. It is shown that, if $g > 5/3 (g < 5/3)$ the solutions are everywhere supersonic (subsonic) with respect to the adiabatic speed of sound. If $1 < g < 5/3$, they possess a critical point, at which the isothermal speed of sound and the flow speed coincide. The winds are examined in the limit $E_\infty \to 0$, and the relation with the breezes is studied. The question of how the particle density (N_0) and temperature (T_0) at the base of the stellar corona determine the type of solution realized outside the star is examined. (UK)

39139 EVOLUTION OF SPHERICAL PROTOSTARS WITH MASSES 0.25 $M_\odot$ TO 10 $M_\odot$. Larson, Richard B. (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 121-45(1972).

The calculations reported earlier (Larson, 1969) for the collapse of a spherical protostar were improved and extended to a wider range of masses with calculations for masses of 0.25, 0.5, 1.0, 1.5, 2.0, 3.0, 5.0, and 10 solar masses. For masses less than ~1.5 $M_\odot$ the results are similar to those obtained previously for a protostar of 1.0 $M_\odot$, and they show that a star in this mass range first appears near the lower end of its Hayashi track. For masses greater than ~1.5 $M_\odot$ the entropy and the radius of the star never become large enough for a "Hayashi" phase to exist, and the star first appears on the radiative pre-main sequence track. For masses greater than ~3 $M_\odot$, the central stellar core evolves all the way to the main sequence before beginning to shine through its surrounding cloud; thus no "normal" pre-main sequence stars should be observed with masses much greater than ~3 $M_\odot$. The model calculations were compared with most of the observations thought to relate to star formation or newly formed stars. (UK)

39140 REDDENING, DISTANCE MODULUS, CHEMICAL COMPOSITION, AND AGE OF THE GALACTIC CLUSTER NGC 752. Bell, R. A. (Univ. of Maryland, College Park). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 147-56(1972).

The uvbyβ colours of the stars in the galactic cluster NGC 752 were analyzed using theoretical colours computed from synthetic stellar spectra. The cluster reddening was found to be small with $E(b - y) = 0.004$ magnitudes. The distance modulus is found to be 7.8 magnitudes and the m_1 indices imply that the cluster may be slightly metal rich ($[M/H] = +0.2$) compared with the Sun. Equivalent width data for one cluster star, originally obtained by Gunn & Kraft, were re-analyzed and were also found to give slight metal richness. The cluster age is found to be about 2.5×10^9 yr, based on Iben's evolutionary tracks for stars of 1.25 and 1.5 $M_\odot$. Not all details of the theoretical isochrones agree with observation and further investigation of evolutionary tracks for stars in this mass range appears warranted. The desirability of obtaining uvbyβ photometry for the old galactic cluster M67 is pointed out. (auth)

39141 BEAT PERIOD OF AX VELORUM. Stobie, R. S.; Hawarden, T. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 157-65(1972).

AX Velorum is a Population I Cepheid with a variable light curve. Analysis of the photoelectric observations of AX Vel revealed two periodicities present (a) the primary wave of period 2.59285 days with amplitude $\Delta V = 0.33$, $\Delta B = 0.49$ corresponding to pulsation in the first overtone and (b) the secondary wave of period 3.6731 days with amplitude $\Delta V = 0.22$, $\Delta B = 0.28$ corresponding to pulsation in the fundamental mode. The period ratio $P_1/P_0 = 0.70590$ is similar to that found in previous analyses of beat period Cepheids. (auth)

39142 BEAT PERIOD OF Y CARINAE. Stobie, R. S. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 167-70(1972).

Autocorrelation analysis of the photoelectric observations of Y Car showed two periodicities present (a) the primary wave of period 3.639760 days with amplitude $\Delta V = 0.58$, $\Delta B = 0.78$, and (b) the secondary wave of period 2.559 days with amplitude $\Delta V = 0.28$, $\Delta B = 0.35$. The period ratio is 0.7031. (auth)

39143 SURFACE PARAMETERS AND COMPOSITION OF SOME HIGH VELOCITY A-STARS. Rodgers, A. W. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 171-8(1972).

Continuum and line spectrophotometry of bright high-velocity A-stars is reported and effective temperatures and surface gravities are derived. The surface abundance of Ca is found from the strength of the line Ca II K λ3933 Å and compared with that in Population I stars of the same temperature. Seven stars of the sample are blue horizontal-branch stars. Only two stars, 7 Sex and HD 26298, appear to have Ca abundances which are near solar. (auth)

39144 LINE SPECTRA OF HELIUM IN GASEOUS NEBULAE. Brocklehurst, M. (University Coll., London). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 211-27(1972).

The level populations of neutral helium are calculated for conditions typical of gaseous nebulae. Full collisional redistribution of angular momentum and energy is included, and accurate helium atomic data are used throughout. Intensities of the most important singlet and triplet line series are presented for $n \leq 25$. It is suggested that the collisional excitation of 3^3D and 4^3D is overestimated in the calculations of Cox and Daltabuit (1971). (auth)

39145 TWO NEW BETA CANIS MAJORIS VARIABLES: ϵ CEN AND δ LUP. Shobbrook, R. R. Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 5P-9P(1972).

ϵ Cen and δ Lup were discovered to be two additions to the rapidly growing list of broad-lined β CMa variables. They range in light during their short periods over only about 0.01 and 0.003 mag, respectively. The variation of ϵ Cen is fairly well represented by two periods of 0.169608d and 0.17696d. The periodicity in the rather small range of δ Lup is not determined with certainty, but is either 0.16547 (most probable) or 0.14273d. The photometric errors and the reality of the deviations from the adopted periods in ϵ Cen, δ Lup, and also in λ Sco and κ Sco are discussed. (auth)

39146 MASS-LUMINOSITY RELATIONSHIP OF THE HYADES AND OTHER STARS. Alexander, J. B. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 11P-13P(1972).

Although the mass—luminosity relationship of the Hyades cluster is poorly determined at present, it is probable that the unevolved stars in the cluster are somewhat undermassive when compared with typical unevolved field stars of the corresponding luminosity. For stars in the general field, there is no evidence for two discrete mass—luminosity relationships. (auth)

39147 PULSATING HELIUM STARS. Trimble, Virginia (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 156: No. 4, 411-18(1972).

Linear and nonlinear pulsation computations established the existence of an instability strip for helium ($X = 0.0$) stars. A 2 $M_\odot$ model with $L \times 3.3 = 10^{37}$ erg s^{-1}, $T_e = 6000$°K, and $Z = 0.03$ reproduces the period and velocity curve found by Feast for RY Sgr (an R CrB variable which also exhibits periodic variations). The discrepancies between the observed and calculated light and temperature curves can be understood at least qualitatively. (auth)

39148 INTERNAL DYNAMICS OF THE OBLIQUE ROTATOR. Mestel, L.; Takhar, H. S. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc.; 156: No. 4, 419-36(1972).

The field of motions within a magnetic oblique rotator is constructed by a double perturbation technique, assuming strict adiabaticity. The dissipation of energy through radiative conduction and turbulent viscosity is estimated roughly, yielding time scales for rotation of the angle χ between the magnetic and rotation axes. If the star is dynamically oblate about the magnetic axis, χ steadily decreases; if prolate, χ increases. Oblateness or prolateness is probably determined by the relative strengths of the poloidal and toroidal magnetic flux. The estimated dissipation rates suggest that the large obliquity required for most of the Ap stars can be achieved well within a stellar lifetime. There is also the possibility that in other stars—e.g., in late-type stars with oblique magnetic flux trapped beneath the convective envelope—the dissipation rate may be too slow, so that the motions persist through the stellar lifetime. The consequent mixing of material could be significant for stellar evolution. (auth)

39149 COLLAPSE OF A ROTATING CLOUD. Larson, Richard B. (Yale Univ., New Haven). Mon. Notic. Roy. Astron. Soc.; 156: No. 4, 437-58(1972).

Numerical calculations were made for the early stages of collapse of an axisymmetric cloud, both with and without rotation. The results show that, in the absence of rotation, deviations from spherical symmetry do not usually grow as the cloud collapses; instead, pressure forces remain sufficient to maintain rough spherical symmetry and prevent the cloud from fragmenting during its collapse. Fragmentation can occur, but usually only if the initial configuration is already unstable to fragmentation. In the presence of rapid rotation, however, the central part of the cloud always appears to condense into a rotating "doughnut" or ring with a density minimum at the centre. Such a rotating ring is almost certainly unstable and will presumably fragment into two or more condensations orbiting around each other. The formation in this way of a binary or multiple system of stars would largely resolve the classical "angular momentum problem" and might account for the fact that most stars are in fact found in binary or multiple systems; even the single stars might be accounted for as escapers from unstable multiple systems. (auth)

39150 ELECTRONOGRAPHIC PHOTOMETRY OF STAR CLUSTERS IN THE MAGELLANIC CLOUDS. III. THE COLOR-MAGNITUDE DIAGRAM OF NGC 2257. Walker, Merle F. (Univ. of California, Santa Cruz). Mon. Notic. Roy. Astron. Soc.; 156: No. 4, 459-69(1972).

Electronographic magnitudes and colours of stars in the cluster NGC 2257 in the Large Magellanic Cloud were measured on electrographs taken with a Spectracon image-converter attached to the f/7.5 focus of the 60-inch reflector at Cerro Tololo. The colour–magnitude diagram was derived to V = 22.3 and is basically similar to those of the classical "Population II" globular clusters in our Galaxy, although certain differences exist. The most striking of these is a gap in the giant branch at the magnitude level of the horizontal branch; the star density appears to be zero within this gap. The colour distribution of the horizontal branch stars and the colour and shape of the sub-giant branch are similar to those of the extremely metal-poor cluster M92. However, the height of the red-giant branch at $(B-V)_0 = +1.4$ is only $\Delta V = 2.55$, as in the intermediate metal content globulars M3 and M13, although this value is somewhat uncertain owing to the very small number of red giants in the cluster. Thus, NGC 2257 may be interpreted either as: (1) a cluster with extremely low metal content like M92 but with an abnormally low red-giant branch, or (2) a cluster of intermediate metal deficiency like M3 or M13 which shows the "M13 anomaly" in the distribution of its horizontal branch stars and in which the giants above the horizontal branch lie mostly on the asymptotic-giant branch. If the absolute visual magnitude of the horizontal branch at the blue edge of the variable star gap is M_V (BG) = +0.4, then the apparent visual distance modulus of NGC 2257 is $(m-M)_{AV} = 18.7$, in agreement with the distance of the main body of the Large Magellanic Cloud derived from the Cepheid variables. However, since it is possible that no unique value of the brightness of the horizontal branch exists, a definite determination of the distance modulus is not possible. (auth)

39151 CaOH, A NEW TRIATOMIC MOLECULE IN STELLAR ATMOSPHERES. Pesch, Peter (Case Western Reserve Univ., Cleveland). Astrophys. J.; 174: No. 3, L155-6(15 Jun 1972).

A strong absorption band at ~λλ5500 to 5560, which occurs in spectra of late-type M-dwarf stars but not in those of late-type M giants, is tentatively attributed to the triatomic molecule CaOH. (auth)

39152 H–R DIAGRAM OF THE OPEN CLUSTER IC 2602. Abt, H. A. (Kitt Peak National Observatory, Tucson, Ariz. Cerro Tololo Inter-American Observatory, Arecibo, Puerto Rico); Morgan, W. W. Astrophys. J.; 174: No. 3, L131-5(15 Jun 1972).

Revised spectral types were determined for Whiteoak's cluster members of types A0 and earlier. The resulting H–R diagram showed a rather narrow main sequence and a previously known silicon star, HD 92664; the spectrum of the latter showed well-marked absorption lines over the excitation range from C II λ4267 to Sr II λ4077. The most remarkable feature of the cluster was the spectrum of its brightest star, θ Car: lines of N III were abnormally strong, while C III was abnormally weak; these characteristics suggest membership in a peculiar spectral category described by Walborn. (auth)

39153 SHORT-PERIOD OSCILLATIONS IN ETA CARINAE. Lasker, B. M.; Hesser, J. E. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Nature (London) Phys. Sci.; 237: No. 74, 73(29 May 1972).

Eta Carinae was studied for short-period optical oscillations from data obtained in the 1968–1969 observing season and, following a suggestion that the various optical phenomena associated with this object may be excited by a pulsar, observations were extended to high frequencies. Results indicated that there were no short-period oscillations with amplitudes >0.008 mag. and in the range 0.028 to 408 s. No significant coincidences in the frequencies at which maxima appeared in the power spectra were found, and there were no obvious nonatmospheric continuum features in the power spectra. The possibility could not be excluded, however, that there may be some pulsar-like phenomena associated with Eta Carinae, but the null result might be taken in support of the suggestion that this object is a young massive object in its early evolutionary stages. (UK)

39154 EMISSION SPECTRUM OF THE ION C IV IN PLANETARY NEBULAE. Leibowitz, Elia M. (Harvard Coll. Observatory, Cambridge, Mass.). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 97-102(1972).

A theory is developed for the calculation of the energy-level population of an ion in planetary nebulae; radiative excitation is taken specifically into account. The theory is applied in the computation of the spectrum of C IV under different excitation conditions and yields measurable differences between a pure recombination spectrum of this ion and a spectrum of radiatively excited C IV. Intensity ratios of C IV lines observed in NGC 1535 and perhaps those observed in NGC 3242, 7027, 7662, 6886, 6884, IC 2165, 5117 and Anon 21n31m may be interpreted as the results of radiative excitation of C IV. No observational evidence can be found for radiative excitation of C IV in the planetary nebulae NGC 7009 and 2440. The intensity of the C IV λ 5810 line computed with a radiative excitation theory, with a carbon-to-helium ratio in nebulae similar to that in stellar atmospheres, is of the same order of magnitude as the intensity of this line observed in NGC 7027. (auth)

39155 POLARIZATION OF C IV EMISSION LINES IN PLANETARY NEBULAE. Leibowitz, Elia M. (Harvard Coll. Observatory, Cambridge, Mass.). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 115-20(1972).

If the ion C IV is radiatively excited in a planetary nebula, three of its emission lines should be polarized when observed with a slit spectrograph in a suitable position with respect to the nebular image. One of the lines, λ3936, should be observable and perhaps should also be strong enough to allow the detection of its polarization. (auth)

39156 PHOTOMETRIC STUDY OF THE OPEN CLUSTER NGC 2477. Hartwick, F. D. A. (Univ. of Victoria, British Columbia); Hesser, James E.; McClure, Robert D. Astrophys. J.; 174: No. 3, 557-72(15 Jun 1972).

A photometric study of NGC 2477 based on the combined results of photoelectric and photographic UBV photometry and intermediate-band photometry on the David Dunlap Observatory (DDO) system yielded the following results: (1) A differential reddening across the cluster ranging from $E_{B-V} = 0.2$ to $E_{B-V} \simeq 0.4$ mag. (2) A relative metallicity of approximately 1.5 times that of the Hyades. (3) A deficiency of stars on the evolved main sequence between apparent magnitudes $13.87 \lesssim V \lesssim 14.10$. (4) A true distance modulus of $(m-M)_0 = 10.61 \pm 0.21$. (5) Comparison between theoretical model computations and the observed features of the color–magnitude diagram yielded an age of $1.5 \pm 0.2 \times 10^9$ years. (6) A group of stars lying above and blueward of the turnoff point. These stars have apparently lower surface gravities than main-sequence stars. (auth)

39157 RR LYRAE STARS IN BAADE'S FIELD NEAR NGC 6522. Hartwick, F. D. A. (Univ. of Victoria, British Columbia); Hesser, James E.; Hill, Graham. Astrophys. J.; 174: No. 3, 573-82(15 Jun 1972).

From a reinvestigation of the RR Lyrae stars in Baade's field near NGC 6522, it was found that: (1) Among 38 variables, 84% of the periods originally determined from the hour-angle–limited data of Baade were spurious. The period–frequency diagram for the galactic center variables is similar to that of M5 (NGC 5904), a typical Oosterhoff Type I cluster. (2) If the origin of these stars was globular clusters, then the clusters had metal abundances between those of M5 and NGC 6171. (3) Using an absolute magnitude derived from Christy's theoretical relation between $\langle M_V \rangle$ and P_{trans} for RR Lyrae stars, and Baade's luminosity function, the distance to the galactic center was found to be $R_0 = 7.0 \pm 0.6$ kpc. Whether this small value of R_0 should be construed as support for Clube's M_V value or as a suggestion that the theoretical P_{trans} relation needs modification cannot be unambiguously decided from the present data. (auth)

39158 PECULIAR NEBULA M2-9. Allen, D. A.; Swings, J. P. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 174: No. 3, 583-9(15 Jun 1972).

M2-9 is a previously unannounced member of the class of objects possessing strong [Fe II] emission lines in their spectra and having prominent infrared continua. (auth)

39159 Hβ PHOTOMETRY OF GALACTIC NEBULAE AT $|b| > 20°$. Johnson, Hugh M. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Astrophys. J.; 174: No. 3, 591-4(15 Jun 1972).

Hβ is weakly emitted in nebulae at $\langle |b| \rangle = 26°$, and weak Hβ emission may characterize the Galaxy in general at this latitude. The $\langle \beta' \rangle$ measurement is converted into ⟨EM⟩, and this into $\langle n_e^2 \rangle$ and $\langle n_e \rangle$ on alternative assumptions. Derived $\langle n_e \rangle$ agrees with the value derived from pulsar data by others. The fraction of space in the solar neighborhood filled by photographic nebulae is estimated incidentally. Attention is drawn to the possible analogy of the observed nebulae to fragments of the Gum Nebula. (auth)

39160 TEMPERATURE SCALE OF F AND G STARS. I. HYDROGEN LINE PROFILES. Schmidt, Edward G. (Univ. of Arizona, Tucson. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 174: No. 3, 595-603(15 Jun 1972).

Hα profiles were obtained for 28 Cepheids and 67 nonvariable F, G, and K stars of all luminosity classes. These observed profiles were compared with theoretically calculated profiles to find effective temperatures. The asymmetry and width of the line core were used as criteria to determine whether each profile can be used for this purpose. It was found that gross asymmetries caused by pulsation destroy the usefulness of the profiles in some Cepheids and at some phases in other Cepheids. Broad line cores limit the usefulness of the profiles at lower temperature in both Cepheids and nonvariables. The temperatures were used to obtain color excesses for these stars. The absolute magnitudes of the G and K stars were obtained from the measured line-core widths following Kraft, Preston, and Wolff. (auth)

39161 TEMPERATURE SCALE OF F AND G STARS. II. CONTINUUM PHOTOMETRY. Schmidt, Edward G. (Univ. of Arizona, Tucson). Astrophys. J.; 174: No. 3, 605-15(15 Jun 1972).

Measurements of the slope of the Paschen continuum for 28 nonvariable F, G, and early K stars and 20 Cepheids are presented. From these data, line-blocking coefficients and temperatures are derived through comparison with model-atmosphere energy distributions. A comparison with the results of Paper I indicates that the temperatures obtained from the spectral scans are cooler by about 170° than those obtained from Hα. Color-temperature and spectrum-temperature relations are derived from this data and compared with previous results. From the data obtained in this paper and that of Paper I the location of the supergiants in the H–R diagram is considered; it is found that there are five nonvariable stars in the present sample which lie within the instability strip and five more which are very close to the edge of the strip and may be inside it. The hot edge of the instability strip from theoretical calculations is compared with the present temperature scale, and it is found that the hottest Cepheids lie outside the theoretical instability strip even when a helium abundance of 45% is used. (auth)

39162 ECLIPSING-BINARY SOLUTIONS BY SEQUENTIAL OPTIMIZATION OF THE PARAMETERS. Nelson, Burt (San Diego State Coll., Calif.); Davis, Walter D. Astrophys. J.; 174: No. 3, 617-28(15 Jun 1972).

This is a method of solving the light curves of eclipsing binaries with small computers in reasonable amounts of time. Total, annular, and partial eclipses can be treated with equal ease in the case of spherical stars and in some cases of nonspherical stars. Very small ratios of the radii present no great difficulties, nor does orbital eccentricity. The program computes the area eclipsed at a given phase angle without the use of auxiliary functions and converges to a solution by minimizing the sum of $(O - C)^2$. (auth)

39163 EXISTENCE AND UNIQUENESS THEOREMS CONCERNING THE H-MATRIX OF RADIATIVE TRANSFER. Siewert, C. E.; Burniston, E. E. (North Carolina State Univ., Raleigh). Astrophys. J.; 174: No. 3, 629-41(15 Jun 1972).

A solution to the system of singular-integral equations and the linear constraint which define mathematically the H-matrix relevant to the scattering of polarized light is shown to exist and to be unique. A discussion of a class of canonical solutions to the matrix Riemann problem is given, and the H-matrix is then expressed in terms of a convenient canonical solution. Cauchy's theorem is then used to develop the nonlinear integral equation convenient, when used with the linear constraint, for computing the H-matrix, and the required existence and uniqueness theorem is proved. For the special case of conservative Rayleigh scattering, an explicit analytical result for the appropriate canonical matrix is given. (auth)

39164 NATURE OF SOME FAINT INFRARED STARS. Lee, Thomas A. (Univ. of Arizona, Tucson). Astron. J.; 77: No. 5, 374-5(Jun 1972).

Photometry extending from 0.7 to 3.4 μm is presented for a sample of Haro–Chavira infrared stars. Circumstellar radiation is not necessary to explain the observations. These objects appear to be ordinary reddened late-type M giants or Mira variables. (auth)

39165 UBV AND H_γ OBSERVATIONS OF EARLY-TYPE FIELD STARS. Lutz, Julie H. (Univ. of Illinois, Urbana); Lutz, Thomas E. Astron. J.; 77: No. 5, 376-80(Jun 1972).

Photoelectric UBV and H_γ data are presented for 157 early-type stars. These stars all lie within 4° of the galactic plane, and many of them show considerable reddening. (auth)

39166 HIGH-LUMINOSITY BOUNDARY OF THE β CEPHEI INSTABILITY STRIP. Percy, John R.; Madore, Katherine (Univ. of Toronto). Astron. J.; 77: No. 5, 381-3(Jun 1972).

Twenty stars, slowly rotating, more luminous than $M_V = -5.0$, and lying slightly above the upper main sequence were tested photometrically for short-period light variations of the type found in β Cephei stars. None of the stars showed such variations. It was concluded that β Cephei variability is found infrequently or not at all in stars more luminous than $M_V = -5.0$. (auth)

39167 EXPECTED INFRARED SPECTRA FROM PLANETARY NEBULAE. Terzian, Yervant; Sanders, David (Cornell Univ., Ithaca, N. Y.). Astron. J.; 77: No. 5, 350-4(Jun 1972).

Infrared spectra for 16 planetary nebulae and one larger H II region (NGC 6888) were computed, assuming thermal radiation from pure graphite grains surrounding the nebulae. The predicted spectra were compared with the existing infrared observations and general agreement was found. It was indicated that several planetary nebulae should be detectable from ground-based infrared observations at λ21 μm. (auth)

39168 ABSOLUTE MAGNITUDES OF THE BARIUM STARS. MacConnell, D. J. (Univ. of Michigan, Ann Arbor); Frye, R. L.; Upgren, A. R. Astron. J.; 77: No. 5, 384-91(Jun 1972).

In the course of the Michigan Spectral Survey of the southern sky 205 new Ba stars were discovered. The survey employed objective-prism plates with a dispersion of 108 Å/mm at Hγ and was intended to cover the entire sky south of declination +30°. Plates were examined that cover 85% of the sky south of the equator. The newly identified stars, along with the 35 previously known objects of this kind, were divided into two groups on the basis of the presence and strength of the λ4554 line of Ba II. Of the total number, 150 unmistakably showed the λ4554 feature, whereas, in the remaining 90 stars, the existence of this line was less certain. Proper motions are known for 120 of the former or "certain" Ba stars and 78 of the latter or "marginal" Ba stars. Mean absolute visual magnitudes were derived from the upsilon components of the proper motions reduced to the FK4 system. They were −0.4 and +1.0 for the certain and marginal groups separately, and +0.2 for a combined solution, assuming the motions reflect the standard solar motion and assuming a standard deviation in M_V of ±0.8M. Both groups appeared to possess kinematical properties resembling those of young stars. The mean luminosities of both were equivalent to normal giants; thus they were considerably fainter than normal stars with comparable Sr II-line intensities. It is estimated that Ba stars are about 1% as abundant as normal G and K giants in the vicinity of the Sun. (auth)

39169 BINARY NATURE OF THE B SUPERGIANT IN THE ERROR BOX OF THE VELA X-RAY SOURCE. Hiltner, W. A. (Univ. of Michigan, Ann Arbor); Werner, J.; Osmer, P. Astrophys. J.; 175: No. 1, L19-22(1 Jul 1972).

The B0.5 Ib star in the error box of 2U 0900 − 40 is a spectroscopic binary with a provisional period of 7.0 days and a semiamplitude of 26 km s^{-1}. The minimum mass of the secondary star is near 1.4 $M_\odot$. (auth)

39170 GRAVITATIONAL REDSHIFT OF 40 ERIDANI B. Greenstein, Jesse L. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.); Trimble, Virginia. Astrophys. J.; 175: No. 1, L1-5(1 Jul 1972).

Image-tube coudé spectra of the DA white dwarf 40 Eri B gave an independent determination of the gravitational redshift as +27 km s^{-1}; prime-focus spectra give +16 km s^{-1}, or a mean +23 ± 5 km s^{-1}. The agreement with the theoretical mass–radius prediction is within the experimental errors of both. No large quadratic Zeeman effect exists. Sharp cores of Hα and Hβ apparently arise from non-LTE effects. The maximum allowable projected rotational velocity suggests a long period. If contraction of a red-giant core leads to a white dwarf, then either the red-giant core did not rotate rapidly or it lost magnetic field and angular momentum. The coudé measures now preclude a large systematic error in the prime-focus redshifts of DA stars. (auth)

39171 CIRCULAR POLARIZATION OF OMICRON SCORPII: POSSIBLE INTERSTELLAR ORIGIN. Kemp, James C. (Univ. of Hawaii, Honolulu). Astrophys. J.; 175: No. 1, L35-7(1 Jul 1972).

Definite circular polarization was discovered in light from o Sco (HD 147084, $m_V = 4.6$), one of the bright stars with large linear polarization and large interstellar reddening. The maximum observed magnitude was at λ4300, where $q = -(4.1 \pm 1.0) \times 10^{-4}$. One explanation is a varying grain-alignment direction along the line of sight. (auth)

39172 NUCLEOSYNTHESIS OF RARE NUCLEI FROM SEED NUCLEI IN EXPLOSIVE CARBON BURNING. Howard, W. Michael; Arnett, W. David; Clayton, Donald D.; Woosley, Stanford E. (Rice Univ., Houston, Tex. Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. J.; 175: No. 1, 201-16(1 Jul 1972).

It is demonstrated that a Population I concentration of primordial heavy seed nuclei, when present in the carbon- and oxygen-rich core of the presupernova star and exposed to the temperature and free nucleon densities of explosive carbon burning, is efficiently transmuted into the rare species ^{36}S, ^{40}K, ^{40}Ar, ^{43}Ca, ^{46}Ca, ^{48}Ca, ^{45}Sc, ^{47}Ti, ^{49}Ti, ^{50}Ti, ^{50}V, ^{62}Ni, ^{64}Ni, ^{68}Zn, ^{70}Zn, and ^{76}Ge in approximately their solar-system abundance ratios. If the temperature is high enough ($T_9 \simeq 2.1$) that at least 10% of the Fe and Ni seed nuclei undergo (p,n) reactions during the explosion, the nuclei ^{65}Cu, ^{67}Zn, ^{71}Ga, ^{73}Ge, and perhaps ^{75}As can also be synthesized. These nuclei comprise virtually all of the relatively rare neutron-rich nuclei in the range $36 \leq A \leq 76$ except ^{54}Cr and ^{58}Fe. The dependence of the results upon the rates of important nuclear reactions, most of which are unknown are emphasized. The temperature, density, and timescale of the carbon explosion all have a strong influence on the results as well. This paper is regarded as an exploratory survey of a very difficult problem that will give increasing information about nucleosynthesis as nuclear facts and models of nuclear explosions become more secure. (auth)

39173 REDISTRIBUTION OF RESONANCE RADIATION. I. THE EFFECT OF COLLISIONS. Omont, A.; Smith, E. W.; Cooper, J. (Univ. of Colorado, Boulder). Astrophys. J.; 175: No. 1, 185-99(1 Jul 1972).

The techniques of modern line-broadening theory are used to investigate the scattering of polarized radiation in the rest frame of an atom undergoing collisions. The formulation explicitly included both elastic and inelastic (quenching) collisions. When the lower state had zero width, a form for the redistribution function similar to that of Zanstra is obtained, but with the redistribution in the neighborhood of the resonance line being caused solely by elastic collisions. In the limit of no collisions, but with both levels of finite lifetime, the result of Weisskopf and Woolley is obtained. The effect of level-degeneracy is also explicitly included; in this case the results are a function of the polarization of the light and the different relaxation rates for the multipolar components of the atomic states. (auth)

39174 FISSION THEORY OF BINARY STARS. Lebovitz, N. R. (Univ. of Chicago). Astrophys. J.; 175: No. 1, 171-83(1 Jul 1972).

The fission theory is reformulated so as to be independent of the action of viscosity. It is found that this results in evolution not along the Jacobi series, but along a similar series of ellipsoids, the lower self-adjoint series of Riemann. The evolution takes place on the contraction timescale t_c, even in the neighborhood of points where a dynamical instability sets in. This circumstance frees the present formulation from the objection, frequently raised against the classical formulation, connected with the occurrence of a dynamical, or ordinary, instability of the ellipsoidal series under disturbances belonging to the third ellipsoidal harmonics. Certain other objections that have been raised against the fission theory are also reconsidered. (auth)

39175 MAGNETICALLY DISTORTED POLYTROPES: STRUCTURE AND RADIAL OSCILLATIONS. Trehan, S. K. (Univ. of Colorado, Boulder); Uberoi, Mahinder S. Astrophys. J.; 175: No. 1, 161-9(1 Jul 1972).

The equilibrium structure of a gaseous polytrope with a toroidal and a poloidal magnetic field is examined under the assumption that the magnetic energy is small compared with the gravitational energy of the configuration. It is found that the magnetic field tends to be more centrally condensed with increasing value of the polytropic index n. The resulting configuration is a prolate spheroid, the prolateness being a decreasing function of n. The ratio of the magnetic energy of the toroidal component to that in the poloidal component varies approximately as n^3 for the lowest characteristic mode of the magnetic field. The radial oscillations of the configuration are examined by means of a variational principle. The frequencies of oscillation are tabulated for various values of γ. The shift in the frequency due to the presence of the magnetic field increases with the value of γ. (auth)

39176 POLARIZED RADIATION FROM MAGNETIC WHITE DWARFS: EXACT SOLUTION OF KEMP'S MODEL. Chanmugam, G.; O'Connell, R. F.; Rajagopal, A. K. (Louisiana State Univ., Baton Rouge). Astrophys. J.; 175: No. 1, 157-9(1 Jul 1972).

An exact quantum-mechanical calculation of Kemp's magneto-emission process, for magnetic white dwarfs at low temperatures, is presented and the implications discussed. (auth)

39177 TRANSFER OF POLARIZED RADIATION IN A STELLAR ATMOSPHERE. Collins II, George W. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J.; 175: No. 1, 147-56(1 Jul 1972).

A method is presented for solution of the equation of transfer for elliptically polarized radiation in an illuminated stellar atmosphere. Although the method is completely general, it is specifically applied to the gray-atmosphere problem in order to demonstrate its accuracy and stability. The main advantage of the method is the separation of the depth dependence of the solution from the angular dependence in situations containing little, if any, symmetry. It is shown that the method can reproduce solutions for problems in which independent solutions are available. Furthermore, the method will handle problems in which the illuminating radiation comes from a finite solid angle over which the defining properties of the radiation field are allowed to vary. (auth)

39178 MERIDIAN CIRCULATION WITH RAPID DIFFERENTIAL ROTATION IN RADIATIVE STELLAR ENVELOPES. Clement, Maurice J. (Univ. of Toronto). Astrophys. J.; 175: No. 1, 135-45(1 Jul 1972).

It is assumed that the turbulent flow found by Smith at the outer boundary of radiative envelopes leads to a conservative rotation law for which the stellar surface is a streamline. Under these conditions, the currents in low-density regions are relatively slow and steady with the possible exception of critical rotation. For all but the fastest rotators, the differential rotation eliminates the outer circulation zone which exists in the presence of rigid rotation. (auth)

39179 PRE-MAIN-SEQUENCE STARS. II. STELLAR POLARIZATION IN NGC 2264 AND THE NATURE OF CIRCUMSTELLAR SHELLS. Breger, Michel (State Univ. of New York, Stony Brook); Dyck, H. Melvin. Astrophys. J.; 175: No. 1, 127-34(1 Jul 1972).

Stellar polarization between 3000 and 7500 Å was measured for NGC 2264. Out of 35 stars, four are definitely intrinsically polarized. The mean cluster polarization (of interstellar origin) is found to be very small. Three of the polarized stars have wavelength dependences of polarization similar to Be stars. It was deduced that the polarizing mechanism is similar in the two classes of objects, namely, electron scattering in an equatorial circumstellar disk. The near-infrared (0.9 to 3.5 μ) photometry of W90 was reinterpreted as arising from low-temperature free–free emission. The polarization data, the visible extinction, and the near-infrared continuum all seem to fit the requirement for free electrons in the circumstellar region. (auth)

39180 HIGH-n BALMER TRANSITIONS IN GASEOUS NEBULAE. Goad, L. E. (Harvard Coll. Observatory, Cambridge, Mass.); Goldberg, L.; Greenstein, Jesse L. Astrophys. J.; 175: No. 1, 117-25(1 Jul 1972).

The intensities of the Balmer lines arising from levels with principal quantum number $n \geq 15$, and the intensity of the apparent continuum formed by the overlapping of the Balmer lines, were measured in the Orion Nebula (NGC 1976) and the planetary nebula NGC 7027. These observed intensities were compared with the predictions of Brocklehurst's recombination theory in order to deduce the electron temperature and density of the nebulae. It was found that $T_e = 8600° \pm 1500°$K and $\log_{10} N_e = 4.1 \pm 0.3$ cm^{-3} for NGC 1976 and that $T_e = 6900° \pm 1500°$K and $\log_{10} N_e = 5.6 \pm 0.3$ cm^{-3} for NGC 7027. (auth)

39181 STUDIES OF EXTREMELY YOUNG CLUSTERS. VI. SPECTROSCOPIC OBSERVATIONS OF THE ULTRAVIOLET-EXCESS STARS IN THE ORION NEBULA CLUSTER AND NGC 2264. Walker, Merle F. (Univ. of California, Santa Cruz). Astrophys. J.; 175: No. 1, 89-116(1 Jul 1972).

Spectroscopic observations of 25 ultraviolet-excess stars in the Orion Nebula cluster and NGC 2264 are presented. These objects are found to be late-type gravitationally contracting stars with masses of 0.2 to 0.5 $M_\odot$, radii of 2 to 6 $R_\odot$, and absolute bolometric magnitudes of +2.5 to +5.8, surrounded by zones in which line and continuous emission originate. In nine of these stars, absorption lines of hydrogen and (sometimes) Ca II having radial velocities of +150 to +400 km s^{-1} are observed, indicating that infall of material is occurring. The rate of infall is variable and amounts to $\lesssim 10^{-6}$ $M_\odot$ per year. The majority of the ultraviolet-excess stars that do not show the redward-displaced absorption lines appear to be similar systems in which the infall rate was lower at the time of observation, or in which infall occurs in a plane perpendicular to the line of sight. Two RW Aur-like stars may be slightly older systems in which infall has ceased. The nature of the ultraviolet excess and blue continuum is not clear, but these features may result from hydrogen emission in the infalling material and/or at the shock front where this material strikes the surface of the star. The blue continuum makes the stars appear too blue in the color-magnitude diagram, and this effect accounts for the tendency of these stars to lie closer to the main sequence than predicted by theory. The ages of the ultraviolet-excess stars appear to be smaller than the ages estimated from the point at which the cluster sequences depart from the main sequence, indicating that a spread in the time of star formation probably exists in these clusters. (auth)

39182 ABNORMALLY METAL-RICH GLOBULAR CLUSTER NGC 6352. Hartwick, F. D. A. (Victoria Univ., Toronto); Hesser, James E. Astrophys. J.; 175: No. 1, 77-88(1 Jul 1972).

A color-magnitude diagram was constructed for the globular cluster NGC 6352 from photoelectric UBV measurements to V ≈ 19 for 63 stars and from photographic B, V measurements of 397 stars on five or more plate pairs. The C–M diagram, which was found to be comparable to those of 47 Tucanae and M71, confirmed the integrated photometry of van den Bergh and indicated that NGC 6352 is indeed metal rich. A blue ''straggler'' sequence was also identified. The following properties were derived for NG3 6352: $E_{B-V} = 0.32 \pm 0.05$ mag, $(m - M)_0 = 13.5 \pm 0.3$ mag, and $[Fe/H] \geq +0.1 \pm 0.1$. Thus NGC 6352 is likely the metal-richest globular cluster known at this time. (auth)

39183 MODEL OF A STATIONARY STELLAR CLUSTER WITH A HIGH BINDING ENERGY. Bisnovatyi-Kogan, G. S. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1593-7(May 1972). (In Russian).

A hierarchical stationary model of a stellar cluster with a spherically symmetric density distribution and a binding energy close to the rest mass energy of the system is proposed. The model is valid for a whole set of distribution functions, including that isotropic with respect to the velocities. (auth)

39184 EMISSIONNYE LINII V SPEKTRAKH ZVEZD. (Emission Lines in Stellar Spectra). Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971). 126p.

A separate abstract was prepared for each of the four parts of this work. (W.D.M.)

For abstracts of individual sections see: 39185–39188.

39185 EMISSION LINES IN STELLAR SPECTRA. I. THE FORMULATION OF THE PROBLEM. Luud, L.; Il'mas, M. pp 3-12 of Emissionnye Linii v Spektrakh Zvezd. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971). (In Russian).

The level population statistical equilibrium equations with five free parameters (T_e, T^*, n_e, W, and β^0_{12}) are written in terms of the Sobolev's theory of moving envelopes, taking into account radiative and electron-impact processes. The dependence of the value β^0_{12} on b_1, n_e and dv/dn is shown. This enables one to check the reality of the free parameters. The transition-probabilities computing methods are briefly discussed. (auth)

39186 EMISSION LINES IN STELLAR SPECTRA. II. CALCULATION OF SOME TRANSITION PROBABILITIES FOR HYDROGEN. Il'mas, M. pp 13-46 of Emissionnye Linii v Spektrakh Zvezd. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971). (In Russian).

The probabilities of radiative ionization and induced recombinations are calculated and presented. Using Gryzinski's theory, the probabilities of ionization and excitation by electron collisions are calculated and presented. (auth)

39187 EMISSION LINES IN STELLAR SPECTRA. III. CALCULATIONS OF THE HYDROGEN SPECTRUM. Il'mas, M. pp 47-110 of Emissionnye Linii v Spektrakh Zvezd. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971). (In Russian).

Using the iteration procedure, the level population statistical equilibrium equations are solved for a hydrogen atom. The values of b_i, β_{2i}, β_{3i}, and I_{2i}/I_{24} are presented. The influence of free parameters on calculated values of b_i, β_{ik}, and I_{2i}/I_{24} is discussed. (auth)

39188 EMISSION LINES IN STELLAR SPECTRA. IV. COMPARISON OF THE OBSERVED AND CALCULATED INTENSITIES OF HYDROGEN LINES. Luud, L.; Il'mas, M. pp 111-24 of Emissionnye Linii v Spektrakh Zvezd. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1971). (In Russian).

The observed and computed decrements of hydrogen lines are compared. It is found that, in the case of P Cyg, a good agreement exists. The agreement for Be stars is poorer. The dependence of the ratios H_α/H_β and H_γ/H_β on T^* for Be stars is in satisfactory agreement with observations. The agreement between the observations and the computed decrements for symbiotic stars is satisfactory enough only for Z And. For AG Dra and AG Peg the dilution $W = 10^{-2}$ as found from the agreement between the computed and observed decrements is too small. A need for a detailed study of representative stars is stressed. (auth)

39189 ERUPTIVE BINARY STARS. PART I. Smak. Jozef (Zaklad Astronomii, Warsaw). Postepy Astron.; 20: No. 2. 91-103(Apr-Jun 1972). (In Polish).

Problems associated with the physical properties of the components and the circumstellar matter and with the mechanisms of outbursts are reviewed briefly. (auth)

39190 MASS OUTFLOW FROM HOT STARS. Zytkow, Anna (Zaklad Astronomii. Warsaw). Postepy Astron.; 20: No. 2, 105-18(Apr-Jun 1972). (In Polish).

A short review is presented of the observational data on hot stars exhibiting the P Cygni-type lines in the far-ultraviolet, thus suggesting mass loss. The theoretical model by Lucy and Solomon of the mass outflow is described. The mass loss in this model is due to an outwardly directed acceleration acquired by the gas by absorption of radiation in the ultraviolet resonance lines. (auth)

39191 DIFFUSION PROCESSES IN STARS. Basinska. Ewa (Pracownia Astrofizyki i Zakladu Astronomii. Torun. Poland). Postepy Astron.; 20: No. 2, 119-37(Apr-Jun 1972). (In Polish).

The physical background of the diffusion phenomenon is given. A review of diffusion in different-spectral-type stars is presented, with emphasis on solar conditions. (auth)

39192 POSSIBILITY OF APPLYING THE X- AND GAMMA-RAY ASTRONOMY TO SOLVING THE PROBLEMS OF COSMOCHEMISTRY AND NUCLEAR ASTROPHYSICS. Kuchowicz. B. (Univ., Warsaw). Postepy Astron.; 20: No. 2. 147-50(Apr-Jun 1972). (In Polish).

Study of linear x-ray spectra may enable one to detect the superheavy elements (from the hypothetical island of stability near the atomic number Z = 114) in at least some of the stars in which one may hope to find them. There are certain arguments in favor of the presence of these elements in the peculiar A stars. One may regard as such the presence of uranium in the star 73 Dra, as well as the abundance of promethium in HR 465. Promethium may be formed in the spontaneous fission of superheavy elements. The methods of quantum chemistry allow one to estimate with sufficient accuracy the energies of the x rays. A study of the gamma spectra for the known radionuclides is simple with a gamma telescope outside the terrestrial atmosphere. An investigation of the changes of individual line intensities with time may provide further needed facts to the theory of nucleosynthesis. It is worth studying the x and gamma spectra of the Ap stars, of supernova remnants, and of the surroundings of pulsars. (auth)

39193 MODELI ZVEZD S PROTYAZHENNYMI ATMOSFERAMI SPEKTRAL'NYKH KLASSOV F-K. (Models of the F-K Stars with Extended Atmospheres). Pustyl'nik, I. B. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1969). 123p.

Separate abstracts were prepared for the two papers contained in this volume. (W.D.M.)

For abstracts of individual papers see: 39194 and 39195.

39194 MODELS OF THE F-K STARS WITH EXTENDED ATMOSPHERES. Pustyl'nik, I. B. pp 3-34 of Modeli Zvezd s Protyazhennymi Atmosferami Spektral'nykh Klassov F-K. /Pustyl'nik, I. B. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1969). (In Russian).

A brief description of the computational procedure and numerical results of calculations for model atmospheres of F–K stars is given. (W.D.M.)

39195 SOLUTION OF THE LIGHT CURVES OF ECLIPSING BINARIES WITH THE AID OF THE FRACTIONAL LIGHT-LOSS TABLES FOR THE ATMOSPHERIC ECLIPSES. Pustyl'nik, I. B. pp 35-121 of Modeli Zvezd s Protyazhennymi Atmosferami Spektral'nykh Klassov F-K. /Pustyl'nik, I. B. Tartu; Tartuskaya Astrofizicheskaya Observatoriya (1969). (In Russian).

A review of spectroscopic and photometric data concerning atmospheric eclipses among Algol-type stars is given. (W.D.M.)

39196 PHYSICAL STATE OF MATTER IN THE INTERIOR OF STARS. PART I. Nemeth, Judit (Lorand Eotvos Univ., Budapest). Fiz. Szemle; 22: No. 4, 97-104(Apr 1972). (In Hungarian).

The development of stars, as they pass through various equilibrium states, is examined. This evolution is controlled by four fundamental differential equations that describe the change of mass, energy flux, pressure, and temperature. The star is viewed as a closed system with an adiabatic surface, containing a variety of radiations and materials. The equilibrium states during the evolution of a star include hydrostatic, thermal, and thermodynamic ones, depending on whether chemical and nuclear reactions are involved in the ongoing processes. The conditions required to attain these states are reviewed, considering various factors, such as convective energy transfer, the energy generating density, and opacity of the system. Solution of the differential equations involved is indicated, pointing out the importance of exact boundary conditions. (TTT)

39197 HELIUM ABUNDANCE IN THIRTY-THREE MAIN SEQUENCE B STARS. O'Mara, B. J.; Simpson, R. W. (Univ. of Queensland, Brisbane). Astron. Astrophys.; 19: No. 2, 167-88(Jul 1972).

The importance of non-LTE effects in neutral-helium line formation in main-sequence B stars was determined. Helium abundances were derived assuming LTE for thirty-three main sequence B stars ranging in spectral type from B8 to B0. The large number of stars analyzed revealed definite trends in the behavior of He I lines that were attributable to deviations from LTE. (W.D.M.)

39198 MIXED MODELS FOR BLUE HORIZONTAL-BRANCH STARS. Petersen, J. Otzen (Univ. of Copenhagen). Astron. Astrophys.; 19: No. 2, 197-9(Jul 1972).

The evolution of Population II models assumed to be mixed by the helium flash was investigated. It is shown that such models can describe the bluest stars of the horizontal branches of globular clusters without the assumption of mass-loss prior to the horizontal branch stage, but not the main group of blue horizontal-branch stars. (auth)

39199 SPECTRUM VARIATIONS OF THE Be HD 217050 STAR. Granes, P. (Observatoire, Meudon, France). Astron. Astrophys.; 19: No. 2, 224-30(Jul 1972). (In French).

The variations of the Hβ line profiles would be correlated to radial velocities variations. (auth)

39200 MODEL ATMOSPHERE ANALYSIS OF THE Ap STAR HR 465. Aller, Margo F. (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 19: No. 2, 248-60(Jul 1972).

A detailed model-atmosphere analysis of the Ap spectrum variable HR 465 is presented for three well-spaced epochs. The analysis is based on 2-Å/mm spectrograms secured at the coudé focus of the Lick 120-inch telescope and a continuous energy distribution obtained with the University of Michigan 52-inch telescope. A representative model characterized by $\Theta = 0.475$ at $\log \tau_{5000} = -0.20$, by $\log g = 3.7$ and by $\xi_{micro} = 4$ km/s was selected from a grid by comparison of observed and theoretical continuous energy distributions, hydrogen-line profiles and metal-line profiles. Overabundances of the order of 10^3 or more are found for the rare earths, Mo, and Nb; of order 10^2 for Sr and Zr, and of order 10 for the iron-peak elements. Smaller overabundances are found for Al and Si. The results of the abundance analysis are discussed in terms of several current theories proposed to explain the Ap abundance anomalies. (auth)

39201 METAL-TO-HYDROGEN RATIO IN F1–F5 STARS, AS DETERMINED BY A MODEL-ATMOSPHERE ANALYSIS OF PHOTOELECTRIC OBSERVATIONS OF A GROUP OF WEAK METAL LINES. Gustafsson, B. (Uppsala Univ.); Nissen, P. E. Astron. Astrophys.; 19: No. 2, 261-82(Jul 1972).

Photoelectric observations of the strength of a group of weak metal lines in the spectra of 74 F1–F5 stars, including eight Hyades and six Pleiades stars, were carried out with an echelle spectrometer. They were analyzed as a function of the fundamental atmospheric parameters with the aid of hydrogen-line-blanketed model atmospheres, which were computed by a new and very effective method of the Feautrier type. The Fe/H ratios derived for the group of F1–F5 Population I stars range from the Hyades value to a factor of 3 below this value. The Pleiades stars were found to have a Fe/H ratio nearly a factor of 2 lower than the Hyades ratio. Strömgren's Δm_1 index correlated well with the Fe/H ratio. The calibration of Δm_1 in terms of [Fe/H] (denoting the difference between the logarithms of the Fe/H ratio of a star and that of the Sun) was found to be $[Fe/H] = -15\ \Delta m_1 + 0.40$, which is close to the calibration found earlier for F5–G2 main-sequence stars. (auth)

39202 COMMENTS ON THE PAPER "IS THERE PROMETHIUM IN HR 465?" Aller, Margo F.; Cowley, Charles R. (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 19: No. 2, 283 (Jul 1972).

A discussion of the data presented in the paper "Is there promethium in HR 465?" by Havnes and van den Heuvel, (Astron. Astrophys., 19: 284(1972)) is presented. (See following abstract) (auth)

39203 IS THERE PROMETHIUM IN HR 465? Havnes, Ove (Univ. of Oslo); van den Heuvel, E. P. J. Astron. Astrophys.; 19: No. 2, 284-6 (Jul 1972).

A rediscussion of the probability for chance coincidences between laboratory wavelengths and wavelengths in a stellar spectrum shows that the identification of Pm II lines in the spectrum of HR 465 may be due to chance. (auth)

39204 EVOLUTION OF CLOSE BINARY SYSTEMS WITH INTERMEDIATE INITIAL MASS RATIOS. Giannone, P.; Giannuzzi, M. A. (Osservatorio Astronomico, Rome). Astron. Astrophys.; 19: No. 2, 298-302(Jul 1972).

The evolution of the original primaries of three close binary systems with total masses of 3.5 $M_\odot$ and initial separations of 10 $R_\odot$ was computed through the phase of mass exchange between the components. The initial values of the mass ratio were varied in a wide range. The departure from thermal equilibrium of the models of the components losing matter was studied. The final remnants had masses around 0.32 $M_\odot$; two of them became white dwarfs and one a helium star. The results obtained for systems with the same total masses are discussed. (auth)

39205 PHOTOMETRIC STUDY OF THE OPEN CLUSTER NGC 2232. Claria, J. J. (Univ. Nacional, Cordoba, Argentina). Astron. Astrophys.; 19: No. 2, 303-9(Jul 1972).

Three color photoelectric photometry is presented for 43 stars in the vicinity of the southern galactic cluster NGC 2232. Photoelectric measurements of H_β line intensity of 22 early-type stars is also presented. A small and uniform $(B-V)$ color excess of 0.01 m was found for the cluster. Independent analyses of UBV and H_β data confirm that NGC 2232, with a minimum membership of 19 stars, is located at a distance of 360 pc. A good agreement between the absolute magnitude calibrations and intrinsic color relations derived from both UBV and H_β photometry is confirmed. A nuclear age of 20×10^6 years was obtained for the cluster. (auth)

39206 UNRESOLVED DOUBLE-LINED BINARY HR 7774. Smith, Myron A. (Univ. of California, Santa Cruz). Astron. Astrophys.; 19: No. 2, 312-14(Jul 1972).

From variations in spectral line widths and depths, HR 7774 is shown to be an unresolved double-lined binary of period 61 days. A few characteristics of the system are discussed. Both components are probably metallic line A stars with true rotational velocities on the order of 120 km/s. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 38457.

39207 FIRST-EPOCH RADIO OBSERVATIONS OF SUPERNOVA 1970g. Gottesman, S. T. (National Radio Astronomy Observatory, Green Bank, W. Va.): Broderick, J. J.; Brown, Robert L.; Balick, Bruce; Palmer, Patrick. Astrophys. J.; 174: No. 2, 383-8(1 Jun 1972).

Radio observations of the supernova 1970g which occurred in the galaxy M101 were made at wavelengths of 11.1 and 3.7 cm over a 9-month interval and revealed a pointlike source with an intensity $\sim 4 \times 10^{-29}$ W m^{-2} Hz^{-1}. The agreement in position of this source with the supernova was excellent. An extended diffuse component of diameter 0.5 to 2.0 which had a total intensity of 25 to 35 $\times 10^{-29}$ W m^{-2} Hz^{-1} at 11.1 cm was also present near the supernova. It is argued that this latter feature and perhaps also the pointlike component may be associated with the H II region NGC 5445. (auth)

39208 ABSORPTION-LINE PROFILES IN THE QUASI-STELLAR OBJECT PHL 957. Morton, Donald C.; Morton, Winifred A. (Princeton Univ., N. J.). Astrophys. J.; 174: No. 2, 237-52(1 Jun 1972).

This paper continues the analysis begun by Lowrance, Morton, Zucchino, Oke, and Schmidt on the high-resolution spectrum of PHL 957 (z_{em} = 2.69) obtained with the Princeton integrating television system at the coudé focus of the Hale telescope. Each absorption line was assumed to be formed in a homogeneous medium with the absorption coefficient represented by a Voigt profile whose broadening was due to only the Doppler motions in a Maxwell distribution and the natural damping of the transition. Estimates were made of the Doppler widths and column densities required to fit the profiles of most of the identified lines. These results were used to check the validity of some of the redshift systems. Three systems were found in which the Doppler width for the Lα line appeared to be 2 to 10 times greater than the width of a heavy ion with the same redshift. Lyman-α profiles were fitted to all the stronger unidentified lines, and the derived Voigt parameters showed that in all but one case the corresponding Lβ in the low-resolution spectrum would have been too weak to detect. (auth)

39209 LABORATORY MEASUREMENT OF THE 2-CENTIMETER, 2_{11}–2_{12}, TRANSITION OF NORMAL FORMALDEHYDE AND ITS ^{13}C AND ^{18}O SPECIES. Tucker, K. D. (Columbia Univ., New York); Tomasevich, G. R.; Thaddeus, P. Astrophys. J.; 174: No. 2, 463-6(1 Jun 1972).

The hyperfine components of the $2_{11}-2_{12}$ transitions of H_2CO, $H_2{}^{13}CO$, and $H_2C^{18}O$ were measured to an accuracy of about 100 Hz. (auth)

39210 LABORATORY MEASUREMENT OF THE MILLIMETER-WAVELENGTH SPECTRUM OF FORMALDEHYDE. Nerf, R. B. Jr. (Columbia Univ., New York). Astrophys. J.; 174: No. 2, 467-8(1 Jun 1972).

Frequencies of millimeter-wavelength transitions of $H_2{}^{12}CO$ and $H_2{}^{13}CO$ of astronomical interest were measured to a precision generally exceeding one part in 10^6. (auth)

39211 ESCAPE OF RESONANCE-LINE RADIATION FROM EXTREMELY OPAQUE MEDIA. Adams, Thomas F. (Univ. of Arizona, Tucson). Astrophys. J.; 174: No. 2, 439-48(1 Jun 1972).

The escape of resonance-line radiation from a low-density medium is considered in which photon destruction processes are negligible. Numerical solutions are presented for media with large-enough line-center optical depths τ_0 that the effects of the damping wings dominate. The numerical results show that the mean number of scatterings $\langle N \rangle \propto \tau_0$ in this limit, rather than $\langle N \rangle \propto \tau_0^2$ as predicted by Osterbrock. Further, the results show that $\langle N \rangle$ is independent of the value of the damping constant a. These results can be understood if the photons escape in a single longest excursion during which they are trapped in the wings and diffuse a distance comparable to τ_0. The existence of a simple scaling law relating solutions for which the product $(a\tau_0)$ is the same is also noted. (auth)

39212 ABSORPTION OF CRAB NEBULA X-RAYS. Henry, Richard C. (Johns Hopkins Univ., Baltimore); Fritz, Gilbert; Meekins, John F.; Chubb, Talbot A.; Friedman, H. Astrophys. J.; 174: No. 2, 389-97(1 Jun 1972).

The x-ray spectrum of the Crab Nebula closely follows a power law, $I = 9E^{-2.0}$ photons cm^{-2} s^{-1} keV^{-1} for photon energies above 1.5 keV. From 0.2 to 1.5 keV, interstellar absorption strongly attenuates the source spectrum. The equivalent hydrogen density to the Crab is (0.55 ± 0.10) cm^{-3}, in disagreement with the 21-cm absorption value of 0.26 cm^{-3} (a distance of 2 kpc is assumed). The additional x-ray absorption is not expected from the filaments in the Crab Nebula, but could be due to invisible diffuse matter in the nebula. An alternative explanation is possible if interstellar grains contain a significant amount of matter from supernovae. The x-ray spectrum allows one to place the following upper limits on the average volume densities of elements with x-ray absorption edges in the 0.5 to 1.5-keV range: oxygen $<1.5 \times 10^{-3}$ cm^{-3}, neon $<2.5 \times 10^{-4}$ cm^{-3}, silicon $<3 \times 10^{-4}$ cm^{-3}, and magnesium $<1.3 \times 10^{-4}$ cm^{-3}. (auth)

39213 ABSOLUTE MEASUREMENTS OF THE FLUX OF CASSIOPEIA A AND TAURUS A AT 1.87 CENTIMETERS. Wrixon, G. T. (Bell Telephone Labs., Inc., Holmdel, N. J.); Gott III, J. Richard; Penzias, A. A. Astrophys. J.; 174: No. 2, 399-400(1 Jun 1972).

Revised values of the flux at 16 GHz of Cas A and Tau A are presented. The flux of Cas A is 343 ± 19 f.u. (3 σ), and the flux of Tau A is 447 ± 30 f.u. (3 σ). The presence of a previously reported variation in the flux of Tau A has been attributed to an instrumental effect. (auth)

39214 EFFECT OF THE INTERSTELLAR GAS ON THE CONTINUUM SPECTRUM OF 3C 391. Gordon, M. A. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 174: No. 2, 361-3(1 Jun 1972).

Toward low frequencies, the spectral flux density of the supernova remnant 3C 391 is known to decrease to 60% of its maximum at approximately 80 MHz. Observations of radio recombination lines from nearby regions believed to be free of discrete radio sources imply turnover frequencies ($\tau = 1$) of 30 to 110 MHz for the diffuse interstellar gas, thereby suggesting that the low-frequency cutoff of the spectrum of 3C 391 is probably due simply to free–free absorption in the intervening interstellar medium rather than to a decrease in the emission intrinsic to the source. (auth)

39215 FARADAY ROTATION AND SIGNAL DISPERSION: THE GEOMETRICAL OPTICS APPROXIMATION, AN EXACT SOLUTION, AND FIRST ORDER SMOOTHING THEORY. Lerche, I. (Univ. of Chicago). Astrophys. Space Sci.; 13: No. 1, 48-52 (Sep 1971).

The three approximations that were employed to estimate the influence of interstellar fluctuations in both electron density and magnetic field on Faraday rotation and signal dispersion measures in the radio band are discussed. It is demonstrated that: (i) the geometrical optics approximation employed by Ginzburg and Eruhimov (1971) relies on the unproven assertion that all ray paths are essentially the same as the geometrical distance between source and observer; (ii) the exact solution is physically meaningless; (iiii) the purported proof of Ginzburg and Eruhimov that earlier work by Lerche is in error, is itself in error and also self-contradictory; (iv) the first-order smoothing theory employed earlier by Lerche gives the exact correction to the phase of the ordered field provided only that the irreducible part of a three-point correlation function is negligible. (auth)

39216 RADIO MAPS OF 31 EXTRAGALACTIC SOURCES AT 2 7 AND 5.0 GHz. Branson, N. J. B. A.; Elsmore, B.; Pooley, G. G.; Ryle, M. (Cavendish Lab., Cambridge, Eng.). Mon. Notic Roy. Astron. Soc.; 156: No. 4, 377-97(1972).

The Cambridge One-Mile radio telescope was used to map the structures of 31 extragalactic sources at 2.7 and 5.0 GHz. The resolution at 5 GHz was 6.5″ in right ascension and 6.5″ cosec δ in declination. The maps are presented together with physical data derived for the various components. (auth)

39217 IDENTIFICATION OF 5C4 RADIO SOURCES. Barbieri, C.; Bertola, F. (Astronomical Observatory, Padua). Mon. Notic. Roy. Astron. Soc.; 156: No. 4, 399-409(1972).

Two deep-exposure IIIa-J plates obtained with the 48-in. Palomar Schmidt telescope were used to carry out a reidentification of the $_5C_4$ radio sources in the field of the Coma Cluster of galaxies. Several new candidates, including faint clusters of galaxies, are proposed. (auth)

39218 COREQUAKES AND THE VELA PULSAR. Pines, David (Univ. of Illinois, Champaign); Shaham, Jacob; Ruderman, Malvin. Nature (London) Phys. Sci.; 237: No. 75, 83-4(5 Jun 1972).

It is argued that the speedups of the Vela pulsar can be explained by postulating the occurrence of corequakes in a solid core. (auth)

39219 DISCOVERY OF THREE PULSARS. Vaughan, A. E.; Large, M. I. Mon. Notic. Roy. Astron. Soc.; 156: No. 4, 27P-8P(1972).

The radio source survey in progress at Molonglo now incorporates a concurrent search for pulsars. Brief details of the equipment and of three new pulsars are given. (auth)

39220 INTERPRETATION OF RADIO RECOMBINATION LINE OBSERVATIONS. Brocklehurst, M.; Seaton, M. J. (University Coll., London). Mon. Notic. Roy. Astron. Soc.; 157: No. 2. 179-210(1972).

A substantial amount of data from atomic physics is required for the interpretation of radio recombination line observations. A critical review of the available data is presented, and it is concluded that possible errors in this data are no larger than the errors which typically occur in the observational results. The equation of transfer for the line radiation is discussed and a convenient linearized form is obtained. The use of constant density models is discussed and it is shown that such models cannot explain all of the observational results for line-to-continuum ratios and line profiles. A spherically symmetric model is constructed for the Orion Nebula. The electron density N_e is tabulated as a function of the distance r from the centre, and the electron temperature is taken to be 9.5×10^{3}°K. This model gives agreement with the following radio observations, to within observational errors: the total continuum flux as a function of frequency; all observed line-to-continuum ratios; all observed line profiles. The electron temperature is in good agreement with temperatures deduced from the relative intensities of forbidden lines. (UK)

39221 IMPROVED DATA FOR FOUR PULSARS. Lyne, A G.; Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 157: No. 2, 15P-16P(1972).

Periods and pulse shapes, measured at 408 MHz, are given for the pulsars PSR 0301+ 19, 1112 + 50, 1541 + 09, and 2154 + 40. (auth)

39222 NATURE OF THE CEN X-3 SYSTEM. Gratton, L. (Univ., Rome). Nature (London); 237: No. 5354, 329-31(9 Jun 1972).

It is stated that the x-ray flux from Cen X-3 shows large variations of amplitude, variations in periodicity of which are attributed to the Doppler effect, the source being considered to be in circular orbit around a massive body U. Eclipse evidence has been interpreted as indicating that U is a spherical body of mass ~20 $M_\odot$ and radius 13 $R_\odot$, values that are reasonable for a normal giant. Difficulties in assuming that U is a more or less normal giant, however, are discussed. Amongst other findings is that U cannot be an almost normal K giant, since the power it receives from the X star is much longer than, or at least of the same order as, the power radiated by a K star of equal radius, unless the whole system is very close to the Earth, so that the total x radiation from the X star is very small. Another possibility is that Cen X-3 consists either of a relatively close K giant or a more distant β star, orbited by a pulsating X-source, the pair being enveloped by a large and thick cloud of dust that almost entirely absorbs the optical radiation of the star but is transparent to the x radiation. This system should be a powerful infrared source. An interesting model discussed is to assume that the central-mass U is a dark massive highly collapsed body (black hole). (UK)

39223 SEARCH FOR OPTICAL COUNTERPART OF GX3+1. Rodgers, A. W. (Australian National Univ., Canberra). Nature (London); 237: No. 5353, 273-4(2 Jun 1972).

Two sets of spectra of this x-ray source were obtained with the 74 inch telescope at Mount Stromlo. The first with 5 to 6 Å resolution, and covering the range 3400 to 6800 Å, was of star 14 of Kunbel's list (Astrophys. J. Lett. 161: L. 169 (1970)), and the second lay between stars 14 and 15. The spectrum of star 14 is shown; it is roughly of spectral type F8V–G5V and shows no emission or any peculiarity that might suggest a source of high thermal or nonthermal excitation. It is concluded that star 14 is not the source of GX3+1 x-ray emission and that star 15 is also probably not the source of this radiation. There is no evidence of line emission in the region between stars 14 and 15, and a lack of optical identification. (UK)

39224 MULTIPLE REDSHIFTS IN QSOs. Cohen, J. G. (Univ. of California, Berkeley). Nature (London); 237: No. 5353, 273(2 Jun 1972).

It is stated that the quasars PHL 957, Ton 1530, Parkes 0237-23, and 4C 05, 34 are known to show complex absorption spectra, interpreted as due to multiple redshifts; but even allowing ten redshifts per object, 20% or more of the absorption lines with strength two or more remain unidentified. Some possibilities to account for these lines are examined. (UK)

39225 PULSAR FLUX-DENSITY SPECTRA. Backer, D. C. (National Radio Astronomy Observatory, Charlottesville, Va.). Astrophys. J.; 174: No 3, L157-61(15 Jun 1972).

Pulsars 0950 + 08 and 1133 + 16 were observed at 1.4 and 5.0 GHz. A break in their equivalent continuum flux-density spectra near 1.0 HGz suggests a critical scale length of 30 cm in the spatial spectrum of coherently emitting charges. (auth)

39226 DISCOVERY OF A PERIODIC PULSATING BINARY X-RAY SOURCE IN HERCULES FROM UHURU. Tananbaum, H.; Gursky, H.; Kellogg, E. M.; (and others) (American Science and Engineering, Cambridge, Mass.). Astrophys. J.; 174: No. 3, L143-9(15 Jun 1972).

A new pulsating x-ray source with a 1.24-s period was discovered in the constellation Hercules. Analysis of 5 months of data showed the existence of periodic variations in the intensity of the source and correlated sinusoidal variations in the period of the 1.24-s pulsations. As in the case of the pulsating x-ray source Cen X-3, this effect was interpreted as due to an occulting binary system, with the intensity changes due to occultation of the x-ray source by its companion and with the sinusoidal variations in the period of the 1.24-s pulsations due to the Doppler effect. The orbital period for the x-ray source was 1.70017 ± 0.00004d, and the time of occurrence of the center of occultation was UT (1972 January 13.0772 ± 0.0003) ± n(1.70017 ± 0.00004). In addition, a longer-timescale cycle was observed in which the source was bright and pulsing for approximately 9 days during which the 1.7d occulting was observed followed by approximately 27 days during which the source was not detected above background on individual 20-s scans. (auth)

39227 OPTICAL IDENTIFICATION OF CENTAURUS X-3. Margon, Bruce (Univ. of California, Berkeley); Wray, James D. Astrophys. J.; 174: No. 3, L141-2(15 Jun 1972).

It is suggested that the emission-line star WRA 795 is the optical counterpart of Cen X-3, the x-ray pulsar which is a member of an occulting binary system. The star falls in the x-ray error box, which measures only 10^{-2} square degrees, and shows strong emission variability on a timescale of days, similar to HDE 226868, the suggested Cyg X-1 counterpart. (auth)

39228 INTERSTELLAR SCATTERING AND THE SIZES OF ASTRONOMICAL MASERS. Boyd, Robert W.; Werner, Michael W. (Univ. of California, Berkeley). Astrophys. J.; 174: No. 3, L137-40(15 Jun 1972).

The suggestion that scattering by inhomogeneities in the distribution of electrons causes astronomical masers to appear larger than their actual sizes is explored. It is shown that neither scattering near the source nor scattering in the intervening medium is sufficiently strong to produce this effect. (auth)

39229 SEARCH FOR OPTICAL CIRCULAR POLARIZATION IN QUASARS AND SEYFERT NUCLEI. Landstreet, J. D. (Univ. of Western Ontario London. Kitt Peak National Observatory, Tucson Ariz.): Angel, J. R. P. Astrophys. J.; 174: No. 3, L127-9(15 Jun 1972).

A search for optical circular polarization was made in six quasars, the nuclei of three Seyfert galaxies, BL Lac, and OJ 287. With a typical accuracy of 0.1%, no positive effect was found in any of these objects, several of which have been reported to show circular polarization at radio wavelengths. (auth)

39230 GROUPING OF RADIO SOURCES IN THE AREA OF NGC 7331 AND STEPHAN'S QUINTET. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 174: No. 3, L111-14(15 Jun 1972).

An apparent concentration of radio sources is found in a region of about one square degree of sky centered between the large Sb spiral galaxy NGC 7331 and the smaller, disturbed, and generally higher-redshift neighboring galaxies which make up Stephan's Quintet. (auth)

39231 SUPERLIGHT VELOCITY IN QUASARS AND THEIR DISTANCES. Richter, G. M. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Nature (London) Phys. Sci.; 237: No. 74, 71-2(29 May 1972).

It is stated that two independent groups of investigators have reported changes in the interferometer patterns of 3C 273 and 3C 279 between Oct. 1970 and Feb. 1971, and that the simplest models for the patterns involve double sources with increasing separation. The corresponding linear velocities at the distances of the sources, if the redshift is cosmological, are up to ten times the velocity of light. Two models have been presented to explain these "superlight velocities" (Cavaliere, Morrison, and Sartori, Science, 173: 525(1971)). In the present communication an interesting property of one of these models is pointed out. The model may be used to derive the distance of variable sources for which Z is unknown, e.g., BL Lac. A feature of the model is the possibility of discriminating between models of the Universe; measurements on only a few quasars with $Z \approx 2$ would restrict the range of suggested cosmological models considerably. (UK)

39232 CLASSIFICATION OF PULSAR ROTATING ELECTROMAGNETIC FIELDS. Endean, V. G. (Oxford Univ.). Nature (London) Phys. Sci.; 237: No. 74, 72-3(29 May 1972).

Reference is made to Mestel (Nature Phys. Sci., 233: 149(1971)). The present author gives some further results and examines the implications of these results for the possible models of the pulsar magnetosphere, including the hydromagnetic model and the simplified cylindrical field model. Conclusions are reached that have relevance for models where radio pulses are generated near a star surface by particles accelerated to highly relativistic speeds away from the magnetic polar regions. (UK)

39233 HIGH RESOLUTION OBSERVATIONS OF W51. Martin, A. H. M. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 31-40(1972).

The northern part of the H II region W51 was observed with the Cambridge One-Mile telescope at 2.7 and 5 GHz. Compact components were found whose emission measures agreed well with those derived from a non-LTE analysis of recombination line data (Hjellming & Davies) (1970). The two brightest condensations coincided with 2-μ infrared sources, and must be ionized by more than one O star. (auth)

39234 OBSERVATIONS OF RADIO SOURCES WITH FLAT SPECTRA. Fanaroff, B. L.; Blake, G. M. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 41-53(1972).

A study was made of 10 radio sources that appeared from published spectral data to have straight spectra with spectral index $\alpha \sim 0.3$. Detailed consideration of the spectral and angular diameter data showed that, for most of the sources, the spectrum is either the resultant of several components or else is self-absorbed at low frequencies. There is no definite evidence that the flat spectrum of any of the sources is due to a flat electron energy distribution. If the redshifts of quasi-stellar objects are cosmological, then the luminosity distribution of the sources agrees with that predicted from an extrapolation of the properties of sources in the 3C catalogue that includes the effects of cosmological evolution. (auth)

39235 PULSE BROADENING DUE TO MULTIPLE SCATTERING IN THE INTERSTELLAR MEDIUM. Williamson, Ian P. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 55-71(1972).

It has been observed that the pulses received from pulsars are broadened at low frequencies, and this effect is thought to be due to multipath propagation in the interstellar medium. The pulse broadening is investigated in the limit of strong multiple scattering, in which ray optics is applicable. Two cases are considered: the scattering medium is assumed either to be concentrated in a small fraction of the line of sight near the pulsar, or to extend over the whole line of sight. Analytical solutions for the probability density function are found for these two cases, with the aid of the theory of Wiener integrals of Kac and Blanc-Lapierre & Fortet. Both solutions are characterized by a slow rise to a decay which rapidly becomes exponential. The relation between this exponential decay time constant and the rms broadening of the angular size of the source is found, and compared with that expected on the basis of the "thin-slab" model in which the scattering medium is effectively confined to a plane approximately midway between source and observer. (auth)

39236 OBSERVATIONS OF RAPID BLUE VARIABLES. VI. SCORPII X-I. Robinson, Edward L.; Warner, Brian (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 85-95(1972).

Photometric observations of Sco X-I with 1-s time resolution are reported. Power spectrum analysis made during a time of strong flares on Sco X-I shows no evidence of long-lived periodic oscillations. The power spectrum of the light curve, immediately following the final flare of a series of flares, shows a peak with maximum near a period of 165 s. It is shown that the light curve itself during this interval is nonperiodic and that the peak in the power spectrum is more naturally understood as the high-frequency remnant of the spectrum that was obtained during the flare stage. (auth)

39237 EXTENSION OF LOOP III INTO SOUTHERN LATITUDE. Milogradov-Turin, Jelena (Univ., Belgrade). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 1P-4P(1972).

The galactic radio feature, Loop III, is prominent only north of the galactic plane. A new 38-MHz survey has revealed features south of the plane that appear to be continuations of the loop. The spectrum of the loop appears to extend with constant index down to 38 MHz. (auth)

39238 EFFECT OF TENSOR FORCES ON COMPOSITION OF DENSE MATTER. Pandharipande, V. R.; Garde, V. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 39B: No. 5, 608-10(29 May 1972).

Two models of hyperonic matter, in which the ($^3S_1-^3D_1$) tensor forces are treated explicitly through short-range tensor correlations, are studied with the variational method. The results indicate that, at high densities, matter consists of neutrons only, while at low densities, a few percent admixture of other particles may occur. (auth)

39239 RADIATION FROM FLARES NEAR THE MAGNETIC POLES OF PULSARS. Glencross, W. M. (University Coll., London). Nature (London); 237: No. 5351, 157-8(19 May 1972).

It is generally accepted that pulsar emission is produced by material ejected from the surface of rotating neutron stars near the magnetic poles, the charged particles being thought to radiate as they are accelerated along magnetic field lines; but the exact mechanisms by which emission is produced over the full range of the spectrum from γ rays to radio frequencies are not understood. The present author points out that this radiation could be produced by the flare mechanism proposed to explain solar observations. Emission from a flare on a neutron star will be highly directional, so that radiation will be observed at the Earth during only part of each rotation, thus giving rise to the characteristic pulses. In considering how the electromagnetic spectrum can be produced, the case of NP 0532 is considered. The question as to how the charged particles become bunched, so that emission is coherent, is discussed. Conditions might be close to pinch instability. Emission from electrons will be in the γ- and x-ray range, while radio emission will be produced by protons. Emission should be highly polarized, and as a result radiation should be observable only when the particles are travelling towards the observer. Many features of pulsar emission are explained by this model. (UK)

39240 PULSAR THEORY. II. RADIATION MECHANISMS. Goldreich, P. (California Inst. of Tech., Pasadena); Pacini, F.; Rees, M. J. Comments Astrophys. Space Phys.; 4: No. 1, 23-8 (Jan-Feb 1972).

The main features of some of the models for the pulsar radiation mechanism are outlined. (W.D.M.)

39241 DETECTION OF SILICON MONOXIDE AT 87 GHz. Dickinson, Dale F. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 175: No. 1, L43-6(1 Jul 1972).

The J = 2 → 1 rotational transition of SiO at 86,847 MHz was found in Sgr B2 and Ori A. The column density in Sgr B2 was calculated to be $\sim 4 \times 10^{13}$ cm^{-2}, and the excitation temperature, ~10°K. (auth)

39242 LABORATORY DETECTION OF MICROWAVE SPECTRUM FOR HNO. Saito, Shuji (Sagami Chemical Research Center, Sagamihara, Japan); Takagi, Kojiro. Astrophys. J.; 175: No. 1, L47-8(1 Jul 1972).

Observed laboratory frequencies of HNO are listed. (auth)

39243 DIFFUSE GALACTIC X-RAYS FROM DISCRETE SOURCES. Silk, Joseph (Univ. of California, Berkeley); Weinberg, Stephen Lee. Astrophys. J.; 175: No. 1, L29-33(1 Jul 1972).

The galactic ridge is interpreted as a population of intrinsically weak x-ray sources, and calculations are presented of the predicted intensity as a function of scale height and radial gradient. Observations of diffuse galactic x radiation above 1 keV impose severe constraints on discrete-source interpretations of the galactic-plane excess observed at 0.25 keV. (auth)

39244 SEARCH FOR NEUTRAL HYDROGEN HIGH-VELOCITY CLOUDS IN THE DIRECTIONS OF SIX GLOBULAR CLUSTERS. Kerr, F. J.; Knapp, G. R. (Univ. of Maryland, College Park). Astron. J.; 77: No. 5, 354-9(Jun 1972).

A search was carried out for high- and intermediate-velocity H I line emission in the directions of six globular clusters whose spectra show high-velocity interstellar Ca II K-line components. In only one out of the six directions, towards M10, was high-velocity H I emission found. A small hydrogen cloud at a velocity similar to that of the calcium line was found a degree away from the cluster M92. (auth)

39245 COMPACT EXTRAGALACTIC NONTHERMAL SOURCES. Strittmatter, P. A. (Univ. of Arizona, Tucson); Serkowski, K.; Carswell, R.; (and others). Astrophys. J.; 175: No. 1, L7-13(1 Jul 1972).

Results of photometry, spectroscopy, and direct photography at visual wavelengths of four additional objects of the BL Lacertae type are reported together with infrared observations to $\lambda = 10\ \mu$ of one of them (OJ 287). The data indicate that these objects are compact sources of nonthermal continuum radiation. They are likely to be extragalactic, and their possible relationship to QSOs is discussed. (auth)

39246 DECAMETRIC RADIO IDENTIFICATION OF AN EXTRAGALACTIC X-RAY SOURCE. Costain, C. H. (Dominion Radio Astrophysical Observatory, Penticton, B. C.); Bridle, A. H.; Feldman, P. A. Astrophys. J.; 175: No. 1, L15-18(1 Jul 1972).

A radio source with an unusually high spectral index between 22 and 81.5 MHz is identified with the Uhuru x-ray source 2U 1706 + 78. It is probably associated with the cluster of galaxies Abell 2256. This identification provides further support for the inverse Compton model of x-ray emission by rich clusters of galaxies. (auth)

39247 LIMITS ON INTERGALACTIC HELIUM FROM THE 3C 273 X-RAY SPECTRUM. Margon, Bruce; Bowyer, Stuart; Lampton, Michael (Univ. of California, Berkeley). Astrophys. J.; 174: No. 3, 471-5(15 Jun 1972).

An x-ray spectrum of the quasi-stellar object 3C 273 in the interval 0.25 to 10 keV was obtained by sounding-rocket observations. The best-fit power-law spectrum had photon index n = 1.3 with no photoelectric absorption. An upper limit on the x-ray optical depth to 3C 273 was calculated from the data, permitting upper limits to be set on the absolute abundance of helium in the intergalactic medium. (auth)

39248 ASTROPHYSICAL MASERS. I. SOURCE SIZE AND SATURATION. Goldreich, Peter (California Inst. of Tech., Pasadena); Keeley, Douglas A. Astrophys. J.; 174: No. 3, 517-25(15 Jun 1972).

The relation between the apparent and actual sizes of maser sources is important in determining their internal physical conditions. This relation is investigated for models of homogeneous maser clouds having spherical and tube-shape geometries. It is found that the apparent linear size of a spherical OH or H_2O maser may be as much as two orders of magnitude smaller than the physical extent of the emitting cloud. On the other hand, the observed size of a maser having the shape of a thick tube is given by its transverse dimensions. The treatment of maser radiation uses rate equations for the level populations and the ordinary equation of transfer. Approximate analytic calculations are presented for all degrees of saturation. The theory is developed in terms of a multilevel scalar atom in which only two levels are coupled by the maser radiation. Thus, the effects of hyperfine splitting and polarization are ignored. (auth)

39249 FLUX DENSITY OF CASSIOPEIA A AT 1440 MHz AND ITS RATE OF DECREASE. Findlay, J. W. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 174: No. 3, 527-8(15 Jun 1972).

The flux density of Cas A at 1440 MHz has been measured over 11 years. The absolute value at epoch 1970.0 and its rate of change with time have been determined. (auth)

39250 SPECTRA OF TEN GALACTIC X-RAY SOURCES IN THE SOUTHERN SKY. Cruddace, Ray; Bowyer, Stuart; Lampton, Michael; Mack, John; Margon, Bruce (Univ. of California, Berkeley). Astrophys. J.; 174: No. 3, 529-48(15 Jun 1972).

Data on 10 galactic x-ray sources located between $l^{II} = 320°$ and $l^{II} = 20°$ were obtained during a rocket flight from Brazil in June 1969. Detailed spectra of these sources were compared with bremsstrahlung, blackbody, and power-law models, each including interstellar absorption. Six of the sources were fitted well by one or more of these models. In only one case were the data sufficient to distinguish the best model. Three of the sources were not fitted by any of the models, which suggests that more complex emission mechanisms are applicable. A comparison of the results with those of previous investigations provided evidence that five of the sources vary in intensity by a factor of 2 or more, and that three have variable spectra. New or substantially improved positions were derived for four of the sources observed. (auth)

39251 LONG-TERM TEMPORAL VARIATIONS OF THE HARD X-RAY FLUX FROM THE CENTAURUS REGION. Schwartz, Daniel A. (Goddard Space Flight Center, Greenbelt, Md.); Peterson, Laurence E.; Hudson, Hugh S. Astrophys. J.; 174: No. 3, 549-55(15 Jun 1972).

The Universtiy of California at San Diego (UCSD) x-ray telescope aboard OSO-III observed the Centaurus region daily from October 1967 to February 1968, and also for five days in June 1968. For this period, a stable minimum flux of 0.33 ± 0.03 photons $(cm^2\ s)^{-1}$ between 7.7 and 38 keV was derived from a persistent hard x-ray source around $l = 305°$. Several single days showed enhanced fluxes; and two extensive flaring episodes, one with a soft and the other with a very hard spectrum, last at least 10 days. (auth)

39252 POLARIZATION MEASUREMENTS OF RADIO SOURCES AT 9.55-mm WAVELENGTH. Hobbs, R. W. (Naval Research Lab., Washington, D. C. Goddard Space Flight Center, Greenbelt, Md.); Waak, J. A. Astron. J.; 77: No. 5, 342-4(Jun 1972).

The position angle and degree of linear polarization at 31.4 GHz are given for 3C 120, 3C 273, 3C 274, 3C 345, 3C 405, and 3C 454.3. The measurements suggest a high rotation measure (810 rad/m^2) for the radio galaxy 3C 274 (Virgo A). Upper limits are set for four other sources, where the uncertainty in the degree of polarization is such that the measured values do not differ significantly from zero. (auth)

39253 OBSERVATIONS OF SOME SMALL-DIAMETER RADIO SOURCES AT 408 MHz. Jauncey, D. L; Hunstead, R. W. (Cornell Univ., Ithaca, N. Y.). Astron. J.; 77: No. 5, 345-9 (Jun 1972).

Accurate positions and flux densities at 408 MHz are given for a selection of 67 radio sources with small-diameter components or peculiar spectra. The mean positional accuracy is ~3″ arc in each coordinate. In several cases the catalogued source is shown to be a close double or to have nearby companions. Comparisons with high-frequency positions show that few of the sources have significant low-frequency extentions, although the improved 408-MHz flux densities result in many noticeable changes in the earlier spectra. (auth)

39254 PHOTOIONIZATION MODELS FOR THE EMISSION-LINE REGIONS OF QUASI-STELLAR AND RELATED OBJECTS. MacAlpine, Gordon M. (Univ. of Wisconsin, Madison). Astrophys. J.; 175: No. 1, 11-30(1 Jul 1972).

Detailed models are presented for the ionization and thermal structure of a gas which is ionized by ultraviolet radiation with a relatively flat, power-law spectrum. Various physical parameters of the calculations, including spectral slope and intensity of the input radiation, volume filling factor for the gas cloud, atomic number density, and helium abundance, are carefully examined in an effort to better understand their effects upon conditions in the nebula and on the predicted intensities of emission lines. Particular attention is given to 3C 273, but the results are applicable to the investigation of all quasi-stellar and related objects. (auth)

39255 OBSERVATIONS OF STRONG INTERPLANETARY SCINTILLATION AT 74 MEGAHERTZ. Armstrong, J. W.; Coles, W. A.; Rickett, B. J. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 77: No. 16, 2739-43(1 Jun 1972).

Observations of the probability density for interplanetary scintillation are given. They are shown to follow a log-normal distribution better than the frequently used Rice-squared distribution. However, observations of strong scintillation are shown to contain more high-intensity spikes than would be expected if the probability distribution for intensity were log normal. An explanation in terms of focusing by large-scale structure is given and shown to be consistent with spacecraft electron-density spectra. (auth)

39256 OPTICAL TIMING OF THE CRAB PULSAR, NP 0532. Boynton, P. E.; Groth, E. J.; Hutchinson, D. P.; (and others) (Princeton Univ., N. J.). Astrophys. J.; 175: No. 1, 217-41(1 Jul 1972).

Absolute times of arrival of NP 0532 pulses were measured over a 2-year period. The data are shown to be consistent with a cubic polynomial which describes the secular slowdown, a sudden increase and subsequent exponential decay of the frequency (the glitch of September 29, 1969), and an intrinsic 1/f noise component in the frequency. (auth)

39257 TIME EVOLUTION OF A ROTATING BLACK HOLE IMMERSED IN A STATIC SCALAR FIELD. Press, William H. (California Inst. of Tech., Pasadena). Astrophys. J.; 175: No. 1, 243-52(1 Jul 1972).

The time evolution is computed of a Kerr (rotating) black hole which is immersed in a perturbing scalar field, uniform at large distances from the hole. The perturbing field produces a torque on the hole which (i) is perpendicular to the field lines; (ii) causes the perpendicular component $J_\perp$ of the hole's angular momentum to decrease exponentially with time $J_\perp = (J_\perp)_{\text{initial}} \exp(-t/\tau)$, $\tau = (3c^5/8\pi G) \times (\text{mass of hole})^{-1} \times (\text{energy density of field})^{-1}$, bringing the hole's total angular momentum J into eventual alignment with the field; and (iii) accomplishes this alignment by converting rotational energy of the black hole into irreducible mass. Extensions of these results to black holes perturbed by external electromagnetic or gravitational fields is conjectured. According to these conjectures "spin–orbit coupling" in a binary star system should not remove a significant fraction of a black hole's intrinsic angular momentum during the system's lifetime against gravitational-radiation damping. (auth)

39258 IMPROVED DATA FOR EIGHT MOLONGLO PULSARS. Vaughan, A. E.; Large, M. I. Mon. Notic. Roy. Astron. Soc.; 156: No. 4, 25P-6P(1972).

The north–south arm of the Molonglo Cross was used to measure pulsar declinations and periods. (auth)

39259 SEARCH FOR CIRCULAR POLARIZATION IN COMPACT SOURCES AT 9 MM WAVELENGTH. Biraud, F. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 19: No. 2, 310-11(Jul 1972).

No circular polarization, at a level of a few percent, was detected at 9 mm from any of 6 compact radio sources. (auth)

Solar Phenomena

Refer also to abstracts 39407 and 39704.

39260 DESCRIPTION OF SOLAR STRUCTURE AND PROCESSES. Gibson, Edward G. (Manned Spacecraft Center, Houston, Tex. Rice Univ., Houston, Tex.). Rev. Geophys. Space Phys.; 10: No. 2, 395-461(May 1972).

A general introduction to solar structure and processes is presented. The Sun is first viewed as a spherically symmetric steady-state system, and the energy generated in the core is traced as it flows outward. The various forms and manifestations of this energy flow and the resulting uniquely defined characteristics of different atmospheric layers are described. The sources of solar activity are assumed to be differential rotation and solar magnetic fields. The interaction of these sources to produce the observed solar cycle, active regions, the active-Sun corona, and solar flares is discussed. In describing solar structure and processes, only elementary physical concepts are utilized. (auth)

39261 INTERACTION CONTRIBUTIONS TO THE SOLAR p–p REACTION. Gari, M.; Huffman, A. H. (California Inst. of Tech., Pasadena). Astrophys. J.; 174: No. 3, L151-3(15 Jun 1972).

Interaction contributions (meson-exchange effects) to the solar p–p reaction are evaluated by using the low-energy theorem results. A correction to the cross-section factor of approximately +10% is found. (auth)

39262 SOME OBSERVATIONS RELATING TO UMBRAL DOTS. Mallia, E. A.; Petford, A. D. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 73-84(1972).

Observations of Fraunhofer lines of singly-ionized metals in the spectrum of a sunspot are used to derive information about inhomogeneities in umbrae. It is found that the line profiles show Zeeman splittings corresponding to magnetic field strengths of about 3000 G. This is a strong indication that the observed profiles originate within the umbra and are not produced by penumbral light scattered into the umbra. This fact, together with the coexistence of strong lines of the MgH molecule and ionized metal lines in the spectra (after these have been corrected for scattered light) would imply that two distinct types of element must be contributing to the umbral spectrum. The hotter elements may exhibit a range of electron temperatures ranging from ~5200°K (photospheric) to perhaps 5550°K. It seems that microturbulence in these elements reaches 1.4 km s^{-1}. (auth)

39263 PLASMA RADIATION FROM COLLISIONLESS MHD SHOCK WAVES. III. TYPE II SOLAR RADIO BURSTS. Smith, D. F. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 174: No. 3, 643-58(15 Jun 1972).

The theory developed in Papers I and II of this series is applied to Type II solar radio bursts. Observations are reviewed, and basic requirements for a theory are established. The case of a shock at the 80-MHz plasma level with a velocity of 1000 km s^{-1}, an Alfvén Mach number of 2.5, and an angle between the plane of the shock and the ambient magnetic field of 3°42′ is examined in detail. To explain a strong Type II burst with a flux of 10^{-18} W m^{-2} Hz^{-1} at the Earth, a shock area of about 4×10^{19} cm^2 is required. If such a shock travelled 1 $R_\odot$, about 10^{30} ergs would be expended. To explain the observed ratio of fundamental/harmonic intensities, the fundamental radiation must be amplified. This theory provides a method for determining the magnetic field in some parts of the corona since the Alfvén Mach number of the shock must lie in the range $2.0 \lesssim M_A \lesssim 2.9$. A possible explanation for the difference in apparent positions of the sources of fundamental and second-harmonic radiation close to the limb is presented. Direct harmonic radiation is not seen because it is absorbed in the shock and in the region immediately behind the shock while fundamental radiation is only seen from a scatter image of the true source. The herringbone features of Type II bursts are most likely the result of a shock wave impinging on a coronal streamer at almost right angles to the axis of the streamer. The connection between Type II and Type IV solar radio bursts is briefly discussed. (auth)

39264 FORCE-FREE MAGNETIC-FIELD STRUCTURES AND THEIR ROLE IN SOLAR ACTIVITY. Barnes, C. W.; Sturrock, P. A. (Stanford Univ., Calif.). Astrophys. J.; 174: No. 3, 659-70(15 Jun 1972).

Magnetic-field structures in solar active regions are expected to be substantially force-free. A method is proposed for calculating such structures by numerical methods. The method is applied to the study of the magnetic-field pattern associated with a sunspot of one polarity surrounded by a magnetic region of opposite polarity when the sunspot rotates with respect to the surrounding region. Rotation introduces a toroidal component of magnetic field, and the associated pressure leads to inflation of the magnetic-field pattern. If the differential rotation exceeds about 180°, the force-free magnetic field has energy greater than that of an open magnetic-field configuration with the same photospheric boundary conditions. It is concluded that, beyond this point, the force-free field structure is metastable and can be converted into an open field structure by an explosive MHD instability. The resulting field pattern is then of the form previously proposed as the site of high-energy solar flares. (auth)

39265 ANISOTROPIC NONCONSERVATIVE SCATTERING IN A SEMI-INFINITE MEDIUM. Wang, Linshu (State Univ. of New York, Stony Brook). Astrophys. J.; 174: No. 3, 671-8 (15 Jun 1972).

Approximate formulae of plane albedo and spherical albedo of a semi-infinite medium were obtained by the application of the exponential kernel approximation. These formulae are shown to be accurate for all values of single-scattering albedos, for strongly elongated scattering phase functions, and for large angles of incidence. (auth)

39266 OBSERVATIONS OF THE ZODIACAL LIGHT FROM THE ECLIPTIC TO THE POLES. Sparrow, J. G.; Ney, E. P. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 174: No. 3, 705-16(15 Jun 1972).

The brightness and polarization of the zodiacal light were measured from the satellite OSO-5, using two photometers of effective wavelengths 4180 and 6820 Å. The satellite configuration restricted the observations to ecliptic longitudes close to 90°, but measurements were made from the ecliptic to the poles. On the ecliptic the intensity of the zodiacal light was found to be 117 S_{10} (blue) and 315 S_{10} (red) with polarizations of 16.5 and 15%, respectively. At the ecliptic poles the zodiacal intensity was 35 S_{10} (blue) with 20% polarization. No temporal changes in zodiacal light were found nor any significant differences in the intensities in the two hemispheres. The direction of polarization of the zodiacal light is shown to be H-pass radial within the accuracy of the determination of ±5°. (auth)

39267 TOPOLOGICAL DISSIPATION AND THE SMALL-SCALE FIELDS IN TURBULENT GASES. Parker, E. N. (Univ. of Chicago). Astrophys. J.; 174: No. 3, 499-510(15 Jun 1972).

It is shown that a large-scale magnetic field possesses a hydrostatic equilibrium only if the pattern of small-scale variations is uniform along the large-scale field. Thus equilibrium obtains only if the variations in the field consist of simple twisting of the lines, with the twists extending uniformly the full length of the field. Any more complicated topology, such as two or more flux tubes wrapped around each other to form a rope, or braided or knotted flux tubes, is without equilibrium, no matter what fluid pressures are applied along the individual lines of force. The result is rapid dissipation and field-line merging, which quickly reduces the topology to the simple equilibrium form. It follows from this general theorem that line merging has important consequences in turbulent fields. In spite of large magnetic Reynolds numbers of the individual eddies, the line merging reduces the small-scale fields in the turbulence below the value for equipartition with the turbulence. The effect has important astrophysical implications. It explains the absence of strong small-scale fields in the solar photosphere and in interstellar space in spite of the vigorous turbulence. (auth)

39268 MONTE CARLO TREATMENT OF LYMAN-ALPHA RADIATION IN A PLANE-PARALLEL ATMOSPHERE. Modali, Sarma B.; Brandt, John C.; Kastner, Sidney O. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 175: No. 1, 265-74(1 Jul 1972).

A Monte Carlo technique involving Stokes vectors was used to obtain the state of polarization and intensity of solar Lα photons as they diffuse through a plane-parallel homogeneous model of Earth's hydrogen envelope. Fine structure of Lα and Doppler redistribution of frequencies were taken into account. Comparison of the results with Heath's observed upper limit for polarization of 1.5% implied an optical thickness $\tau > 7$ and intensities of 8 to 10 kilorayleighs for a solar Lα flux of 5.8 ergs cm^{-2} s^{-1}. (auth)

39269 COMMENTS ON THE DESTRUCTION OF ^{7}Be IN THE SOLAR INTERIOR. Parker, P. D. (Yale Univ., New Haven). Contract AT(11-1)-3074. Astrophys. J.; 175: No. 1, 261-4(1 Jul 1972).

A comparison is made between the rate of the $^7Be(p,\gamma)^8B$ reaction and the rates of three other nuclear reactions which might have been important in destroying ^{7}Be in the solar interior. Alternate reactions for destroying ^{8}B are also examined. (auth)

39270 FLARE-TIME TEMPERATURE IN SOFT X-RAY SOURCES. Deshpande, S. D.; Tandon, J. N. (Univ. of Delhi). Astrophys. J.; 175: No. 1, 253-9(1 Jul 1972).

Temperatures in flare-time soft x-ray sources were obtained for selected events by using measurements in 0.5 to 3 Å and 1 to 8 Å bands from OGO-4/SR-9 satellites. Higher temperature was assumed for emission below 3 Å, and two temperatures (T_1 and T_2) for 0.5 to 3 Å and 3 to 8 Å spectral ranges. It is shown that source temperature falls rapidly in the initial phase of decay with an exponential cooling time constant of about 52 s. Subsequently the rate of fall of temperature becomes slow. The initial rapid fall can be attributed to the presence of a nonthermal component. (auth)

39271 SOLAR-TERRESTRIAL PHYSICS/1970. Proceedings of the International Symposium, Held in Leningrad, USSR, May 12–19, 1970. Dyer, E. R. (ed.). Astrophysics and Space Science Library. Volume 29. Dordrecht, Netherlands; D. Reidel Publishing Company (1972). 936p. f 215.-. (CONF-700571).

Separate abstracts were prepared for: Part I, The Sun, 13 papers; Part II, The Interplanetary Medium, 8 papers; Part III, The Magnetosphere, 11 papers; and Part IV, The Upper Atmosphere, 11 papers. (J.C.W.)

For abstracts of individual papers see: 39272–39285, 39365–39367, 39406–39415, 39430–39442, and 39454–39456.

39272 SOLAR ENERGY SOURCES. De Jager, C. (Astronomical Inst., Utrecht). Astrophys. Space Sci. Libr.; 29: Pt. I, 1-8(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The energy content of the Sun is considered, and mechanisms for the dissipation and emission of the various kinds of energy are examined. The most important energy flux is the radiant flux originating from nuclear reactions in the solar interior. In the outermost 10^5 km of the solar body this flux is transported convectively. On top of the convective layer, a region of about 600 km thick constituting the photosphere and low chromosphere is in near-radiative equilibrium. The structure of the chromosphere and corona is mainly due to a mechanical energy flux emanating from the outer convective region. The various transient solar phenomena, which for a part involve high-energy processes in magnetic regions, demand thermodynamic upgrading of energy, which, in general terms, can only occur in a motion field with locally a non-zero curl, i.e., solar differential rotation or convection. It is shown that the secular decrease of solar rotational energy can be due to the emission of transformed rotational energy by flares. It is suggested that this happens through the intermediary of differential rotation, which in turn originates by coupling of the solar rotation with convection. (auth)

39273 STRUCTURE AND DYNAMICS OF THE SOLAR CORONA. Kuperus, M. (Univ. of Utrecht). Astrophys. Space Sci. Libr.; 29: Pt. I, 9-20(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The structure of the outer solar atmosphere is discussed in the context of the processes of energy transfer that play a part in the solar corona. Special emphasis is laid on the competitive role played by the four main energy processes, dissipation, radiation, heat conduction, and hydrodynamic expansion. A steadily heated quiet outer solar atmosphere may be divided into several rather distinct layers according to the dominance of one or more of the processes mentioned before. The influence of solar activity and magnetic fields on the structure and energy balance of the corona is discussed, particularly the consequences for the heat flow and solar wind in coronal streamers. (auth)

39274 LARGE-SCALE MAGNETIC FIELDS AND ACTIVITY PATTERNS ON THE SUN. Bumba, V. (Astronomical Inst., Ondrejov, Czech.). Astrophys. Space Sci. Libr.; 29: Pt. I, 21-37(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The recent results concerning the large-scale magnetic field and solar activity distribution are summarized. The static characteristics for three types of such large-scale features are given: (a) Giant regular structures (super-supergranules) are probably the largest elements in the hierarchy of solar convective cells, which can be defined in the solar atmosphere, for example, by magnetic-field patterns, faculae, calcium flocculi, and the organization of active regions. (b) Active longitudes are the longitude sectors with grouped activity and concentrated magnetic fields. The grouping lasts in the same sector for many successive rotations. These active longitudes may have different rates of shift in heliographic longitude per rotation in a given system of coordinates. They are demonstrated not only on magnetic synoptic charts arranged by latitude zones but may also be followed on Zürich Heliographic Maps of the Photosphere for at least four cycles. This means that the organization of activity and fields in streams or active longitudes does not change during several decades and proceeds in the same way following the same rules of development. (c) Active latitudes may also play a role in the formation of large-scale patterns. The dynamics of large-scale features is presented. The active longitudes develop as consecutive complexes of activity that are separate impulses of activity, being usually in opposite phase if two longitudes are active. Giant regular structures develop analogously to supergranules or granules if the background magnetic field in the active longitude reaches a certain level. A possible theoretical explanation of the formation of large-scale patterns, including the "influence of the planets" is discussed. The Sun as a star and the manifestation of longitudinal and latitudinal distributions of the solar magnetic field in the interplanetary magnetic field are considered. Problems of long-term forecasts of important solar events on the basis of recurrences in the large-scale magnetic field and activity patterns are shown. (53 references) (auth)

39275 LOCAL MAGNETIC FIELDS ON THE SUN. Severnyi, A. B. (Crimean Astrophysical Observatory, Simferopol, USSR). Astrophys. Space Sci. Libr.; 29: Pt. I, 38-48(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The strongest magnetic fields on the Sun are those of sunspots. At sufficiently large distances from a spot the magnetic field can be well approximated as that of a dipole submerged below the solar photosphere, but a detailed study shows the fine structure of the field. Concentrations of strong magnetic fields in small portions of the solar plasma have been found. Steshenko (1967) found that even in small 2″ pores the magnetic field can reach values of 1000 gauss and more. Attempts have been made to explain the formation of a sunspot as the result of a redistribution or an assembling of magnetic fields from a large area by convection or supergranulation in the lower layers of the convective zone. In regions of enhanced magnetic fields magnetoacoustic waves can appear and the strong damping of these waves can be a source of heat. At the same time high-frequency plasma oscillations can appear in these regions and these oscillations can heat the plasma; the enhancement of short-wave radio emission in these regions points to this possibility. The relationship between chromospheric structures and magnetic fields can be traced outside active regions. The role of magnetic fields in nonstationary processes, especially solar flares, is considered. A relationship is observed between flares and the change of the net magnetic flux through the active region. This change of the flux could be connected with the appearance of an emf through the boundary of the region. (54 references) (J.C.W.)

39276 PROPERTIES OF SOLAR-ACTIVE REGIONS. Bruzek, A. (Fraunhofer Inst., Freiburg i. B.). Astrophys. Space Sci. Libr.; 29: Pt. I, 49-60(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Solar activity includes different phenomena occurring in the photosphere, the chromosphere, and the corona. These active phenomena are structures such as spots, plages, filaments, flares, and coronal condensations; gradual and impulsive enhancements of radiation in the euv, x-ray, and radio region of the solar spectrum; motions and ejections of solar plasma and the acceleration of fast electrons and protons. The fundamental physical condition of an active region is an enhanced magnetic field that controls or produces the observed phenomena. In the photosphere concentrations of magnetic flux with field strengths >1200 G give rise to the dark sunspots; extended magnetic fields of some tens up to several hundred gauss that permeate the chromosphere and the corona are responsible for the plage phenomena, the coronal condensation, and the associated enhanced radiations; magnetic fields support and shape prominences and play a determining role in flare occurrence. A discussion of the solar-active regions includes (1) appearance of new active regions, (2) strong field phenomena (spots, etc.), (3) moderate magnetic-field phenomena (plages, coronal condensations, and their emissions), and (4) flares. (108 references) (J.C.W.)

39277 PERMANENT SOURCES OF PARTICLE EMISSION FROM THE SUN. Pick, Monique (Meudon Observatory, France). Astrophys. Space Sci. Libr.; 29: Pt. I, 61-71(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Protons of energies less than a few MeV are present continuously for periods of several days. During the last solar minimum, these protons might appear in interplanetary space with a recurrence of 27 days over many solar rotations. It is argued that the particles are of solar origin. For the majority of cases, particle events are related with active regions on the Sun, even during solar minimum. The hypothesis of acceleration of particles in interplanetary space is rejected. Solar corpuscular streams are confined in interplanetary magnetic sectors that can be relatively stable for several rotations. The 27-day recurrence is attributed to two different causes that will be discussed: the first is long-term storage of solar particles; the second is the successive formation of active centers in the same sector and at neighboring longitudes. Active centers responsible for solar corpuscular events may modify the magnetic sectors in which these particles are confined and by this mechanism the particle pattern itself may be modified. These modifications and some aspects of the magnetic sector origin will be discussed. (auth)

39278 SOLAR DISCRETE PARTICLE EVENTS. Svestka, Z. (Astronomical Inst., Ondrejov, Czech.). Astrophys. Space Sci. Libr.; 29: Pt. I, 72-86(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The review includes discussions on: classification of particle events and the problem whether all flares are associated with particle emission of some kind; relations of the flare capability of particle emission to properties of associated active regions; differences in the size of proton events and the reasons for them; improved knowledge of electron events, pure electron and proton events, and the possibility of two different acceleration processes on the Sun; directly observed evidence of acceleration processes on the Sun and some consequences deduced from these observations; and the acceleration phase in the flare development. (57 references) (auth)

39279 SOLAR RADIO BURSTS. Boischot, A. (Meudon Observatory, France). Astrophys. Space Sci. Libr.; 29: Pt. I, 87-98(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The mechanisms by which electrons radiate radio waves in the solar atmosphere are normal bremsstrahlung, magnetic bremsstrahlung, and conversion of plasma waves. From the point of view of particle production by the Sun, three types of bursts are studied. The type-IV burst corresponds to a large burst of energetic electrons accompanying flares; these electrons are either trapped in the low corona giving the microwave type-IV burst, or escape to higher altitudes to give Metric type IV. Protons are accelerated at the same time, as shown by the good correlation between the arrival of protons at the Earth and the occurrence and intensity of type-IV burst in the cm and dm range. The second type is the impulsive microwave burst, which is due to high-energy electrons and which radiates from the same region where the x-ray bursts come from. The third type of burst related to particle ejection is the type-III burst. It has been shown that a stream of electrons that give the type-III burst can reach large distances from the Sun. The problem exists of computing the number and energy of electrons involved in each of these emissions. (J.C.W.)

39280 EVIDENCE THAT SOLAR X-RAY EMISSION IS OF PURELY THERMAL ORIGIN (ALSO OBSERVATION OF FAR-UV FLASH DURING AUGUST 28, 1966 PROTON FLARE). Chubb, Talbot A. (Naval Reserach Lab., Washington, D. C.). Astrophys. Space Sci. Libr.; 29: Pt. I, 99-118(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

X-ray emission from the Sun, as thus far observed, is fully interpretable as thermal plasma emission from sets of hot plasmas at different temperatures. Solar-minimum conditions are characterized by the presence of only a few plage regions, which dominate x-ray emission below 20 Å. Activity events under these conditions can cause a large increase in flux below 20 Å in coincidence with a decrease in emission between 44 and 60 Å, as the silicon and magnesium ions that dominate 44 to 60 Å emission move to higher stages of ionization. Under flare conditions temperatures rise to the 10 to 30 million degree regime, with the higher temperature portions of the plasma dominating the shorter wavelength portions of the spectrum. Thus, flare temperatures calculated from the ratio of S XV and S XVI lines are slightly higher than values calculated from the Si XIII and Si XIV lines, and no major discrepancy exists between these temperatures and temperatures calculated from x-ray continuum emission in the 4 to 6 Å part of the spectrum. The emission from most flares in the 1 to 6 Å region is from plasmas that are too cool to contain observable numbers of one-electron iron and calcium ions. The short bursts of very high energy x rays accompanying strong explosive type flares also show a multithermal spectral character. None of the hard (>20 keV) x-ray spectra show evidence of monoenergetic electron swarms. A rare burst of far-ultraviolet radiation was observed during the flare of August 28, 1966. The burst lasted four minutes and was coincident with emission of hard (>80 keV) x-rays and with the visible brightening and disappearance of a small subregion of the flare, as seen in Hα. (auth)

39281 PARTICLE ACCELERATION AND PLASMA EJECTION FROM THE SUN. Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Astrophys. Space Sci. Libr.; 29: Pt. I, 119-33(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The heating of plasma to high temperatures, the high-velocity plasma ejection, and the acceleration of nonthermal particles are phenomena of solar activity that appear mainly during solar flares. Solar activity was discussed under the following: magnetic nature of solar activity; two main classes of flare models; magnetic cumulation near the magnetic neutral line; current-sheet development, soft phase of the flare; distribution and motion of plasma near the current sheet; current-sheet rupture and hard phase of a flare. The consideration of known flare models shows that the more promising models are those that connect the flare with the release of magnetic energy in excess of the energy of the potential field in the active region. Among these models the model of nonstationary cumulative flow near a magnetic neutral line explains the greatest number of observed facts. (27 references) (J.C.W.)

39282 PARTICLE DIFFUSION IN THE SOLAR CORONA. Elliot, H. (Imperial Coll. of Science and Tech., London). Astrophys. Space Sci. Libr.; 29: Pt. I, 134-50(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The configuration of magnetic fields in the corona is discussed in relation to the escape of energetic solar protons into interplanetary space. In particular an assessment is made of the relative importance of diffusion, drift motions, and direct field-line connections in the distribution of energetic particles in the corona. Observational evidence on particle-flux distributions near the Earth is related to the question of storage in the corona. The absence of marked anisotropies at late times during impulsive solar events is indicative of storage in interplanetary space rather than in the corona. It is concluded that the geometry of coronal magnetic fields is such as to permit storage of protons in the energy range 10 to 100 MeV for several days and that, on occasion, the fields are of such a form as to permit rapid spreading in latitude and longitude and that this, coupled with the stochastic wandering of field lines, can readily account for the observed spread in solar longitude of particles at I AU. (auth)

39283 TIME VARIATIONS IN SOLAR ACTIVITY. Dodson, Helen W.; Hedeman, E. Ruth (Univ. of Michigan, Ann Arbor). Astrophys. Space Sci. Libr.; 29: Pt. I, 151-72(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Long-term variations in the height of solar maxima and in the relative spottedness of the northern and southern solar hemispheres are considered. Mean sunspot numbers in the present solar cycle (number 20) are found to be similar to those in cycles with maxima in 1937, 1917, 1860, and 1769. Time variations within the 11-year cycle are considered. It is pointed out that all solar latitudes and longitudes do not attain maximum levels of activity at the same time. Furthermore, the course of solar activity as measured by sunspot number and 2800-MHz flux is seldom smooth but appears to advance by series of pulses or episodes. The average-time interval between onsets of successive Primary Fluctuations, as have been identified in cycles 19 and 20, was 15 solar rotations. In general, Secondary Fluctuations occurred at intervals of 3 to 5 rotations. These statistical variations in sunspot number corresponded to recognizable episodes in specific solar activity and to maxima in plots of Major Flare and Active Region Indices. Study of the declining branches of solar cycles 12 through 19 suggests that there will be 5 to 6 Primary Fluctuations of activity on the declining branch of cycle 20 in the years 1970.5—1975. At least half of these pulses can be expected to include significantly flare-rich centers of activity. (auth)

39284 METHODS FOR FORECASTING OF SOLAR FLARES. Severnyi, A. B.; Steshenko, N. V. (Crimean Astrophysical Observatory, Simferopol, USSR). Astrophys. Space Sci. Libr.; 29: Pt. I, 173-81(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Phenomena are presented from studies of solar flares and parameters are given characterizing each. The groups studied include proton flares of importance 3 or 3^+ producing cosmic-ray effects recorded with balloons and at ground level; proton flares of importance 3 or 3^+ showing no effect on balloon-borne instruments but showing PCA effect; non-proton flares of importance 3; and non-proton flares of importance 2 or 2^+. Criteria are given that are used for flare forecasting. Most flare-forecast data refer to the structure of active regions at different levels of the solar atmosphere, the structure of magnetic fields and association with flares, and transformations taking place in active regions during a short time interval (1 to 2 days) before and after a flare. As a rule, unipolar and well-defined bipolar spot groups offer no difficulty when considering their further evolution. But eastern regions developing on the back side of the Sun present considerable difficulties. The formation of new active regions is important. Most important in practice is the forecasting of proton and other important flares because of the effects they produce in interplanetary space and in the Earth's environment, resulting in a hazard to space flight. (35 references) (J.C.W.)

39285 LOW-ENERGY COSMIC RAYS IN INTERPLANETARY SPACE. Vernov, S. N.; Lyubimov, G. P. (Moscow State Univ.). Astrophys. Space Sci. Libr.; 29: Pt. II, 92-109(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Data are presented of measurements of low-energy cosmic rays (mainly protons with energies $E_p \approx 1$ to 5 MeV and $E_p > 30$ MeV) from Zond-3 and Venus-2, -3, -4, -5, and -6 space probes for the period 1965–69. During this period the frequency of occurrence, duration, and intensity of the solar cosmic-ray flares increased. Various spatial forms of the solar cosmic-ray increase were found and studied. It has been shown from observations of solar cosmic rays injected by solar flares in 1965–67 that the low-energy protons propagate from the Sun in two ways: (1) rapidly, by means of particle movement along the magnetic-force lines, and (2) slowly, by means of particle transfer in the layer corresponding to the falling phase of the Forbush decrease, i.e., between the shock wave-front and the front of the hot plasma ejected by a flare. Reflection of particles from some "mirror" region and considerable deceleration of shock waves were found in the first and second cases, respectively. It has been shown from the results of comparison of the galactic cosmic-ray decreases with active regions on the Sun that the amplitude of the decrease is determined by the dynamics of active regions, by their latitude, and their phase of development. Characteristic features of the results of 1969 include: the presence of very large and enduring proton fluxes with $E_p > 30$ MeV observed following the shock-wave fronts, a harder spectrum, and complex increases caused by groups of powerful solar flares. Considerable depth and rapid intensity-recovery are features of Forbush decreases in this period while the study of mean velocities of shock-wave propagation indicates a pronounced direction of flare ejections and sustained pushing of shock waves by flare gases. (auth)

39286 X-RAY SPECTRA OF HIGHLY IONIZED IRON AND NICKEL ATOMS. Fraenkel, B. S.; Schwob, J. L. (Hebrew Univ., Jerusalem). Phys. Lett.; 40A: No. 1, 83-5(19 Jun 1972).

Sharp x-ray spectra of extremely high ionized Fe and Ni were obtained by vacuum sparks, with a curved-crystal x-ray spectrometer. Fe XXVI and Ni XXVII were reached. (auth)

39287 NEW MEASUREMENTS OF THE LIGHT POLARIZATION AT THE LIMB OF THE SOLAR DISK. Leroy, J. L. (Observatoire du Pic-du-Midi, Bagneres-de-Bigorre, France. Observatoire, Toulouse). Astron. Astrophys.; 19: No. 2, 287-92(Jul 1972). (In French).

New measurements of the polarization of photospheric light near the solar limb are reported. A short description of the improved version of a previously described polarimeter (Lyot, 1948 a, b; Dollfus, 1958a) is given. The measurements where performed, at the Pic-du-Midi Observatory, during the period 1970–1971, for 6 wavelength intervals. (W.D.M.)

39288 WORKING MODEL FOR SUNSPOT UMBRAE. Stellmacher, G. (Institute d'Astrophysique, Paris); Wiehr, E. Astron. Astrophys.; 19: No. 2, 293-7(Jul 1972).

Comparison of magnetically nonsplit line profiles with the predictions of several umbra models (Stellmacher and Wiehr, 1970) resulted in the selection of three "best umbra models", those by Zwaan, Henoux, and Stellmacher–Wiehr. These models have now been tested by the much stronger criterion of the center-to-limb variation (CLV) of the nonsplit line Fe λ 5434.5 and the Na D-lines. The Stellmacher–Wiehr model best represents these observations. This model is thus able to simultaneously represent the observations of wavelength dependence and CLV of umbra continuum contrasts, the profiles of nonsplit lines including their CLV, and the Na D-lines. This model is proposed as a "working model" for reductions of umbra observations. (auth)

39289 STUDY OF THE SOLAR WIND USING THE POWER SPECTRUM OF INTERPLANETARY SCINTILLATION OF RADIO SOURCES. Bourgois, G. (Observatoire, Meudon, France). Astron. Astrophys.; 19: No. 2, 200-6(Jul 1972).

A discussion is given of the Fourier and Bessel transforms of the time autocorrelation function of the interplanetary scintillations. These transforms exhibit a series of maxima and minima which are related to the Fresnel distance of the plasma blobs responsible for the scintillation phenomenon. The conditions of appearance of these extrema are discussed (Fresnel structures), and it is shown that their observation would allow, in certain conditions, determination of the size of the blobs and the velocity of the solar wind. (auth)

39290 OBSERVATIONS OF PHOTOSPHERIC POLE–EQUATOR TEMPERATURE DIFFERENCES. Altrock, Richard C.; Canfield, Richard C. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys.; 23: No. 2, 257-64(Apr 1972).

Using photoelectric methods Plaskett's (1970) measurements of pole–equator temperature differences were repeated. Many limb-darkening scans were averaged to reduce statistical errors. The differences between the average polar and equatorial scans were analyzed. Plaskett's large pole–equator temperature differences were not confirmed. The data yielded a pole-equator temperature difference of 1.5K ± 0.6K, although systematic errors of 3 to 4K could not be ruled out. (auth)

39291 EMPIRICAL NLTE ANALYSES OF SOLAR SPECTRAL LINES. I. A METHOD AND SOME APPLICATIONS TO EARLIER ANALYSES. Wijbenga, Jan W.; Zwaan, Cornelis (Astronomical Inst., Utrecht). Solar Phys.; 23: No. 2, 265-86(Apr 1972).

A method is suggested for empirical NLTE analyses of solar spectral lines. Special depth-dependent departure coefficients $\beta(x)$ are introduced and the formulas are given for further application. From test calculations it is shown that the separation of the departure coefficients for the upper and the lower level from each other and from the uncertainties in several input parameters (oscillator strength times abundance, turbulent velocities, and damping constant) is greatly facilitated when spectral lines are analyzed on the disk, around the limb, as well as in the flash spectrum. Therefore it is necessary that all accessible line data are used, from accurate line profiles to equivalent widths or integrated intensities. To reduce the number of independent variables the analysis should include many multiplets between a few spectroscopic terms. The advantages of translating the departure coefficients into a set of temperatures are discussed. Some published LTE and NLTE analyses are compared in terms of these temperatures. The results do not show inexplicable contradictions. For several atomic spectra the departures from LTE seem large enough to be established quantitatively by the detailed method suggested. (auth)

39292 BROADENING OF THE SODIUM D-LINES. Lewis, E. L.; McNamara, L. F.; Michels, H. H. (Univ. of Colorado, Boulder). Solar Phys.; 23: No. 2, 287-8(Apr 1972).

Rate coefficients are quoted for the broadening in angular frequency units for a range of temperatures together with the van der Wools' results. In the case of hydrogen the broadening is $\approx 40\%$ larger than the van der Wools' results and for helium an increase of approximately 70% is obtained. In view of the 10 to 15% accuracy expected of these calculations the agreement with the existing evidence is satisfactory. (W.D.M.)

39293 SOLAR ABUNDANCE OF MANGANESE. Blackwell, D. E.; Collins, B. S.; Petford, A. D. (Oxford Univ.). Solar Phys.; 23: No. 2, 292-3(Apr 1972).

Blackwell and Collins (1972) measured oscillator strengths by successive comparisons of absorption lines at increasing furnace temperatures, beginning with the violet resonance lines at 4030.76, 4033.07, and 4034.49, through the green intercombination lines at 5394.67 and 5432.55, and ending with the 5516.77 line. From the 19 lines in this sequence 5 lines were selected for solar analysis. (W.D.M.)

39294 DETECTION OF BLENDS IN THE VICINITY OF ZEEMAN LINES. Wittmann, A. (Univ., Goettingen, Ger.). Solar Phys.; 23: No. 2, 294-9(Apr 1972).

High-resolution spectrograms taken in polarized light revealed the presence of significant blending within the profiles of some important Zeeman multiplets of a large umbra. Wavelength and equivalent width of each depictable blend were derived from the corrected spectrograms and some preliminary identifications were made. (auth)

39295 OBSERVATIONS OF SHORT PERIOD OSCILLATIONS IN TWO DIMENSIONS. Harvey, J. (Kitt Peak National Observatory, Tucson, Ariz.); Howard, Robert. Solar Phys.; 23: No. 2, 300-3(Apr 1972).

Observations of the photospheric velocity field at the disk center with a cadence of five frames per second strongly support the idea that short period oscillations arise from a combination of image motion and horizontal gradients of the line of sight velocity field. Any genuine solar short period oscillations are effectively masked by these false short period oscillations. (auth)

39296 POWER SPECTRUM OF THE PHOTOSPHERIC RESONANCE OSCILLATIONS. Deubner, Franz-Ludwig (Fraunhofer Inst., Freiburg i. B.). Solar Phys.; 23: No. 2, 304-6(Apr 1972).

Recently the author (1972) pointed out that multiple peaks in the Fourier spectra of the 5-min oscillations as reported by others, do not characterize the average solar atmosphere, but result from insufficient statistical stability of the data. The averaged power spectrum of a 18 × 120″ region in the center of the disc observed for 75 min with an aperture size of 3 × 3″ shows only one smooth single peak at 3.2×10^{-3} s^{-1}. Further details are presented. (W.D.M.)

39297 EVOLUTION OF SOLAR MAGNETIC FIELDS OVER AN 11-YEAR PERIOD. Stenflo, J. O. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 23: No. 2, 307-39(Apr 1972).

Digitized data on solar magnetic fields recorded at the Mount Wilson Observatory during the period August 1959–May 1970 were used to study the large-scale evolution of the photospheric magnetic fields. The latitude distribution (butterfly diagram) of the magnetic field was compared with the distribution of sunspots, faculae, prominences, and the intensity of the green-line corona. The evolution of the sector structure of the field was calculated. 36 synoptic charts, each representing an average of four solar rotations, illustrated the evolution of the magnetic field over the 11-year period. (auth)

39298 MACROSCOPIC MOTIONS IN PROMINENCES. I. THE PROMINENCE OF 26th MARCH, 1971. Machado, Marcos E.; Gallegos, Hugo Grossi (Observatorio Nacional de Fisica Cosmica, San Miguel, Argentina). Solar Phys.; 23: No. 2, 340-5(Apr 1972).

Macroscopic velocity fields were studied in a solar prominence. The spectra and monochromatic images were analyzed, and the existence of a contracting motion, possibly due to a pinch effect, is discussed. A helical shape of the prominence is proposed. (auth)

39299 INTERNAL MOTION OF QUIESCENT PROMINENCES. Engvold, Oddbjoern (Univ. of Oslo). Solar Phys.; 23: No. 2, 346-52(Apr 1972).

A study was made of fine-structure wavelength shift in the K line spectra from quiescent prominences. A persistent small scale motion was found in the prominence main body. In places where the characteristic thread-like fine structure in the accompanying Hα filtergrams was seen the average line-of-sight velocity amplitude was about 1 km s^{-1}. A higher velocity (≈ 4 km s^{-1}) was associated with a slightly coarser, mottled prominence fine structure. In the low-lying regions, connecting the prominence body and the chromosphere, any fine-structure line shift ($\nu \leq \frac{1}{2}$ km s^{-1}) was detected. (auth)

39300 ANALYSIS OF TWO ACTIVE PROMINENCES. Machado, Marcos E. (Observatorio Nacional de Fisica Cosmica, San Miguel, Argentina). Solar Phys.; 23: No. 2, 353-9 (Apr 1972).

Observations of two eruptive prominences are discussed, along with the formation of condensations during the phenomena. The density and intensity variations of the condensations are analyzed spectroscopically in one of the events. Some hypotheses about the magnetic field configuration are used in order to explain the observational data. (auth)

39301 COMMENTS ON FILAMENT-DISINTEGRATION AND ITS RELATION TO OTHER ASPECTS OF SOLAR ACTIVITY. Dodson, Helen W. (McMath-Hulbert Observatory, Pontiac, Mich.); Hedeman, E. Ruth; De Miceli, Marta Rovira. Solar Phys.; 23: No. 2, 360-8(Apr 1972).

Studies of "disparitions brusques" in solar cycles 19 and 20(to 1969) indicate that such events occur frequently. Approximately 30% of all large filaments in these cycles disintegrated in the course of their transit across the solar disk. "Major" flares occurred with above average frequency on the last day on which 141 large disappearing filaments were observed (1958–60; 1966–69). Relationships between a disintegrating filament on July 10–11, 1959, a prior major flare, a newly formed spot, and concomitant growth of Hα plage are presented. Observation of prior descending prominence material apparently directed towards the location of the flare of 1959 July 15d19h23m is reported. The development of the filament-associated flare of February 13, 1967 is described. (auth)

39302 INTERPRETATION OF XUV ROCKET MEASUREMENTS OF INTENSITY RATIOS OF SOLAR SPECTRAL LINES OF THE LITHIUMLIKE IONS OVI, NeVIII, AND MgX. Heroux, L. (Air Force Cambridge Research Labs., Bedford, Mass.); Cohen, M.; Malinovsky, Monique. Solar Phys.; 23: No. 2, 369-93(Apr 1972).

A rocket-borne spectrometer was flown to measure absolute intensities of extreme ultraviolet spectral lines from the three ions O VI, Ne VIII, and Mg X present in the Sun. From these measurements, intensity ratios of lines from O VI, ratios of lines from Ne VIII, and ratios of lines from Mg X were formed. These experimental ratios were compared with ratios calculated by using specific theoretical values of the ionization equilibrium in which dielectronic recombination was included in the processes establishing ionization balance. The effects of the electron density and temperature gradient on the temperature distribution of the flux of the spectral lines in the solar atmosphere were taken into account in the calculations of the ratios. The agreement between the experimental and calculated ratios was good for the ions Ne VIII and Mg X and satisfactory for the ion O VI for which the calculated ratio is subject to large uncertainties. A reliable measurement of the electron temperature in the lower corona was obtained from the experimental ratios for Mg X. This experimental temperature was in good agreement with the emission temperature of the spectral lines of Mg X predicted from the theoretical values of the ionization equilibrium. The design and photometric calibration of a new rocket spectrometer developed to measure the intensity ratios over the broad spectral region 50 to 1250 Å are also described. (auth)

39303 DETERMINATION OF THE INTENSITY RATIO OF INFRARED LINES OF THE FeXIII ION. Ratier, G.; Rozelot, J.-P. (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France. Observatoire du Toulouse, Gagneres-de-Bigorre, France). Solar Phys.; 23: No. 2, 394-405(Apr 1972). (In French).

The ratio of the two infrared lines 10747 Å and 10798 Å of Fe XIII was studied from a theoretical and observational point of view. The results and the discussion of the two determinations are summarized into two tables. Arising from a measured ratio of the two lines, a variation of the electron density as a function of dilution factor is given, taking into account the proton impact mechanism in the resolution of excitation equilibrium (as presented by Chevalier and Lambert). The plates were recorded May 25, 1971, for two unperturbed heliographic latitudes. (auth)

39304 ABUNDANCE OF CALCIUM IN THE SOLAR CORONA. De Boer, K. S.; Pottasch, S. R. (Univ., Groningen, Netherlands). Solar Phys.; 23: No. 2, 406-9(Apr 1972).

Recently Fisher (Solar Phys., 19: 431(1971)) derived a coronal calcium abundance of $10^{-4.35}$ from observations of the Ca XV $^3P_1$–$^3P_0$ 5694-Å emission line. Other recent solar values (coronal and photospheric) are about an order of magnitude lower. The causes for the high value are investigated, and it is concluded that Fisher's observations can better be interpreted with a value of about $10^{-5.4}$. (W.D.M.)

39305 DETERMINING THE ELECTRON DENSITY DISTRIBUTION OF THE SOLAR CORONA FROM K-CORONAMETER DATA. Altschuler, Martin D.; Perry, R. Michael (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 23: No. 2, 410-28(Apr 1972).

The electron density distribution of the inner solar corona ($r \leq 2 R_\odot$) as a function of latitude, longitude, and radial distance was determined from K-coronameter polarization-brightness (pB) data. A Legendre polynomial was assumed for the electron density distribution, and the coefficients of the polynomial were determined by a least-mean-square regression analysis of several days of pB-data. The calculated electron density distribution was then mapped as a function of latitude and longitude. The method is particularly useful in determining the longitudinal extent of coronal streamers and enhancements and in resolving coronal features whose projections on the plane of the sky overlap. (auth)

39306 FACULAE AND EAST–WEST ASYMMETRY OF SUNSPOT AREA. Sawyer, C.; Haurwitz, M. W. (Environmental Research Labs., Boulder, Colo.). Solar Phys.; 23: No. 2, 429-37(Apr 1972).

Asymmetry of sunspot area with respect to the central meridian is found to depend strongly on the location of the spot group in its chromospheric facula or plage. The usual area excess for spots in the eastern half of the disk is reversed for the relatively rare spot groups situated in the following part of the plage. Qualitatively, the observed asymmetries can be explained by supposing that the apparent area of the spot is decreased by overlying bright facula, especially west of central meridian where the spot (in the usual preceding position) is viewed through the relatively bright and extensive follower part of the plage. However, the variation with central meridian distance of the mean area of spots and of faculae demands a more complex model, in which the spatial distribution of facula and plage also depends on the location of the spot group. Since both facula and spot effects are seen along the same line of sight, optical depth must change slowly with geometric depth, that is, in the active region the atmosphere is relatively transparent. (auth)

39307 CLASSIFICATION OF MAGNETIC FIELD CONFIGURATIONS ASSOCIATED WITH SOLAR FLARES. Sturrock, P. A. (Stanford Univ., Calif.). Solar Phys.; 23: No. 2, 438-43(Apr 1972).

On the assumption that solar flares are due to instabilities which occur in current sheets in the Sun's atmosphere, one may classify magnetic-field configurations associated with flares into two types. One is characterized by "closed" current sheets, magnetic-field lines adjacent to these sheets beginning and ending at the Sun's surface. The other is characterized by "open" current sheets, magnetic-field lines adjacent to these sheets beginning at the Sun's surface but extending out into interplanetary space. Flares associated with open current sheets can produce Type III radio bursts and high-energy-particle events, but flares associated with closed current sheets cannot. The flare of July 6, 1966 apparently consisted of one flare of each type. (auth)

39308 PROPERTIES OF WHITE LIGHT FLARES. I. ASSOCIATION WITH Hα FLARES AND SUDDEN FREQUENCY DEVIATIONS. McIntosh, Patrick S.; Donnelly, Richard F. (Environmental Research Labs., Boulder, Colo.). Solar Phys.; 23: No. 2, 444-56(Apr 1972).

All four large euv bursts (peak 10 to 1030 Å flux enhancements ≥ 2 ergs cm^{-2} s^{-1} at 1 AU as deduced from sudden frequency deviations), for which there were available concurrent white-light observations of at least fair quality, were detected as white-light flares. The rise times and maxima of the white light-emissions coincided with rise times and maxima of the euv bursts. The frequency of strong euv bursts suggests that white-light flares may occur at the rate of five or six per year near sunspot maximum. All of the white-light flare areas coincided with intense bright areas of the Hα flares. These small areas appeared to be sources of high-velocity ejecta in Hα. The white-light flares occurred as several knots or patches of 2 to 15 arc-sec diameter, with bright cores perhaps less than 2 arc-sec diameter (1500 km). They preferred the outer penumbral borders of strong sunspots within 10 arc-sec of a longitudinal neutral line in the magnetic field. The peak continuum flux enhancement over the 3500 to 6500 Å wavelength range is about the same order of magnitude as the peak 10 to 1030 Å flux enhancement. (auth)

39309 LOCATION OF THE ELECTRON ACCELERATION REGION IN SOLAR FLARES. Kane, S. R.; Lin, R. P. (Univ. of California, Berkeley). Solar Phys.; 23: No. 2, 457-66(Apr 1972).

Observations of impulsive solar-flare x rays ($\gtrsim 10$ keV) by the OGO-5 satellite and the measurements of energetic solar electrons made with the Explorer-35 and Explorer-41 (IMP-5) satellites during the period March 1968-September 1969 were analyzed in order to determine the ion density in the x-ray source region as well as the location of the electron acceleration region in the solar atmosphere. If it is assumed that the efficiency of escape of the accelerated electrons into interplanetary space is $\sim 10^{-3}$, the observations are found to be consistent with the following interpretation: (i) the ion density in the x-ray source region varies from event to event and lies between 10^9 and 10^{11} ions cm^{-3} for those events in which the impulsive x-ray emission could be detected; (ii) for those events in which no impulsive emission was detected above threshold, the ion density in the x-ray source was $<10^9$ ions cm^{-3}; (iii) at least in some small solar flares the region where the electrons are accelerated during the flash phase is located in the lower corona. (auth)

39310 SOLAR FLARES AND SOLAR-WIND HELIUM ENRICHMENTS: JULY 1965—JULY 1967. Hirshberg, J. (Ames Research Center, Moffett Field, Calif.); Bame, S. J.; Robbins, D. E. Solar Phys.; 23: No. 2, 467-86(Apr 1972).

It has previously been suggested that the very high relative abundances of helium occasionally observed in the solar wind mark the plasma accelerated by major solar flares. To confirm this hypothesis, the 43 spectra with He/H $\geq$ 15% that were observed among 10,300 spectra collected by Vela 3 between July 1965—July 1967 were studied. The 43 spectra were distributed among 16 distinct periods of helium enhancement, 12 of which (containing 75% of the spectra) were associated with solar flares. Six new flare-enhancement events are discussed. It is concluded that the association of helium enhancements with major flares is real, nonrandom and very strong. (W.D.M.)

39311 HIGH-ENERGY ELECTRONS DETECTED DURING SOLAR FLARES. Dilworth, C. (Univ., Milan); Maccagni, D.; Perotti, F.; (and others). Solar Phys.; 23: No. 2, 487-500 (Apr 1972).

The S 79 experiment on board the HEOS-A1 European Satellite has been designed to detect electrons whose kinetic energies should be equal or greater than 7.5 MeV. From December 1968 to July 1970, 11 events were observed. Their main characteristics are described. Two different categories of events may be sorted out from these observations. The propagation conditions in the interplanetary space are discussed to find out a possible interpretation. (auth)

Galaxies

39312 RELAXATION TIMES IN STRICTLY DISK SYSTEMS. Rybicki, George B. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. Space Sci.; 14: No. 1, 15-19 (Nov 1971).

It is shown that the time of relaxation by particle encounters of self-gravitating systems in the plane interacting by $1/r^2$ forces is of the same order of magnitude as the mean orbit time. Therefore such a system does not have a Vlasov limit for large numbers of particles, unless appeal is made to some nonzero thickness of the disk. The relevance of this result to numerical experiments on galactic structure is discussed. (auth)

39313 HOSE-PIPE INSTABILITY IN STELLAR SYSTEMS. Kulsrud, R. M. (Princeton Univ., N. J.); Mark, James W. K.; Caruso, A. Astrophys. Space Sci.; 14: No. 1, 52-5(Nov 1971).

Two simple equilibria are the spherically symmetric one, characteristic of stellar clusters, and the one-dimensional slab equilibrium that is closely related to the galactic disk. The nonrotating slab, although not so realistic since it is only a true equilibrium in one direction, has been investigated with some success. An instability in this equilibrium is discussed. (W.D.M.)

39314 EXACT STATISTICAL MECHANICS OF A ONE-DIMENSIONAL SELF-GRAVITATING SYSTEM. Rybicki, George B. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. Space Sci.; 14: No. 1, 56-72(Nov 1971).

The statistical mechanics of an isolated self-gravitating system consisting of N uniform mass sheets is considered, using both canonical and microcanonical ensembles. The one-particle distribution function is found in closed form. The limit for large numbers of sheets with fixed total mass and energy is taken and is shown to yield the isothermal solution of the Vlasov equation. The order of magnitude of the approach to Vlasov theory is found to be $0(1/N)$. Numerical results for spatial density and velocity distributions are given. (auth)

39315 NUMERICAL EXPERIMENTS IN COLLISIONLESS SYSTEMS. Miller, R. H. (Univ. of Chicago). Astrophys. Space Sci.; 14: No. 1, 73-90(Nov 1971).

Difficulties encountered in calculations for collisionless spiral systems are summarized. The calculations deal with particles moving on a plane under $1/r^2$ forces. (W.D.M.)

39316 DYNAMICS OF PLANE STELLAR SYSTEMS. Hohl, Frank (Langley Research Center, Hampton, Va.). Astrophys. Space Sci.; 14: No. 1, 91-109(Nov 1971).

The evolution of initially balanced rotating disks of stars was investigated with a computer model for isolated disks of stars. An isolated, initially cold balanced disk was found to be violently unstable. Adding a sufficient amount of velocity dispersion will stabilize all small-scale disturbances. However, the disks are still unstable against slowly growing long wave-length modes and after about two rotations most disks tend to assume a bar-shaped structure. It was found that the final mass distribution over most of the disk can be closely approximated by an exponential variation, irrespective of the initial mass distribution. The gravitational two-stream instability was investigated by means of a modified computer model for infinite doubly periodic stellar systems. (auth)

39317 NUMBER OF ISOLATING INTEGRALS IN SYSTEMS WITH THREE DEGREES OF FREEDOM. Froeschle, Claude (Observatoire, Nice). Astrophys. Space Sci.; 14: No. 1, 110-17(Nov 1971).

Dynamical systems with three degrees of freedom can be reduced to the study of a four-dimensional mapping. It was found that as soon as $b \neq 0$, i.e., even for a very weak coupling, a dynamical system with three degrees of freedom has, in general, either two or zero isolating integrals (besides the usual energy integral). (auth)

39318 DIRECT INTEGRATION METHODS OF THE N-BODY PROBLEM. Aarseth, S. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Space Sci.; 14: No. 1, 118-32 (Nov 1971).

A fourth-order polynomial method for the integration of N-body systems is described in detail together with the computational algorithm. Most particles are treated efficiently by an individual time-step scheme but the calculation of close encounters and persistent binary orbits is rather time-consuming and is best performed by special techniques. A discussion is given of the Kustaanheimo—Stiefel regularization procedure which is used to integrate dominant two-body encounters as well as close binaries. Suitable decision-making parameters are introduced and a simple method is developed for regularizing an arbitrary number of simultaneous two-body encounters. (auth)

39319 TREATMENT OF CLOSE APPROACHES IN THE NUMERICAL INTEGRATION OF THE GRAVITATIONAL PROBLEM OF N BODIES. Bettis, D. G.; Szebehely, V. (Univ. of Texas, Austin). Astrophys. Space Sci.; 14: No. 1, 133-50(Nov 1971).

One of the main difficulties encountered in the numerical integration of the gravitational n-body problem is associated with close approaches. The singularities of the differential equations of motion result in losses of accuracy and in considerable increase in computer time when any of the distances between the participating bodies decrease below a certain value. This value is larger than the distance when tidal effects become important, consequently, numerical problems are encountered before the physical picture is changed. Elimination of these singularities by transformations is known as the process of regularization. Such transformations are discussed and the numerical approaches to more accurate and faster integration are described. The basic ideas of smoothing and regularization are explained and applications are given. (auth)

39320 INTEGRATION METHODS WHERE FORCE IS OBTAINED FROM THE SMOOTHED GRAVITATIONAL FIELD. Hohl, Frank (Langley Research Center, Hampton, Va.). Astrophys. Space Sci.; 14: No. 1, 168-78(Nov 1971).

The dynamics of collisionless stellar systems can be studied by representing the system by large numbers of representative stars. The numerical methods that are used to integrate the motion of the system in time are presented in some detail. Examples of actual computer experiments can be found in the literature cited. (auth)

39321 EVOLUTIONARY MODELS OF NUCLEOSYNTHESIS IN THE GALAXY. Truran, J. W. (Yeshiva Univ., New York); Cameron, A. G. W. Astrophys. Space Sci.; 14: No. 1, 179-222(Nov 1971).

A model of the Galaxy is constructed and evolved in which the integrated influence of stellar and supernova nucleosynthesis on the composition of the interstellar gas is traced numerically. The detailed assumptions concerning the character of the matter released from evolving stars and supernovae are guided by the results of recent stellar evolutionary calculations and hydrodynamic studies of supernova events. A model is constructed of the Galaxy in which a violent early phase of massive star formation produces both (1) approximately 25% of the level of heavy elements observed in the solar system and (2) an enormous unseen mass in the form of black holes. The implications of the model for other features of the Galaxy, including supernova nucleosynthesis, cosmic-ray production of the light elements, and cosmochronology, are discussed in detail. (100 references) (auth)

39322 RADIO-CONTINUUM RADIATION FROM MESSIER 33. Terzian, Yervant; Pankonin, Vernon (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 174: No. 2, 293-9(1 Jun 1972).

Radio observations of the spiral galaxy Messier 33 are presented at 318 and 606 MHz. These observations were performed with the Arecibo Observatory 1000-foot radio telescope. The brightness–temperature distribution at the higher frequency shows substantial structure which could be identified with the northern and southern spiral-arm regions of M33. The radio spectrum of M33 is discussed, and it is shown that its spectral index is in the range -0.17 to -0.20. This somewhat flat spectrum suggests a mixture of thermal and nonthermal radiation. The thermal radiation from M33 is estimated to be at least 10% of the total radio emission at frequencies ≥ 1 GHz. (auth)

39323 LAGRANGIAN DERIVATION OF THE ACTION-CONSERVATION THEOREM FOR DENSITY WAVES. Dewar, R. L. (Univ. of Maryland, College Park). Astrophys. J.; 174: No. 2, 301-7(1 Jun 1972).

A simple, physical derivation of the continuity equation for wave action is obtained from Hamilton's principle and an averaged Lagrangian density. As an example electrostatic plasma waves are briefly discussed but the primary purpose is to derive the form of the wave action density for galactic spiral waves in a manner that is both simpler and more easily generalized than that of Shu. The wave action density is expressed in terms of a linear response function that may either be taken from previous work, or found from the single-particle averaged Lagrangian. (auth)

39324 MOLECULE FORMATION ON INTERSTELLAR GRAINS. Watson, W. D.; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 174: No. 2, 321-40(1 Jun 1972).

Processes relevant to the formation of molecules (except H_2) on the surface of interstellar dust grains in H I regions are discussed. The sticking probability for heavy (C, N, O, etc.) atoms hitting a grain is close to unity (but is uncertain for C^+ ions). Whether or not chemisorption or quantum-mechanical diffusion is possible, each heavy atom remains on a grain surface long enough for another particle to stick and react with it. A particle that sticks will form some molecule with almost complete efficiency, mainly CH to CH_4, NH to NH_3, OH or H_2O, etc. Some of the unreactive products (CH_4, NH_3, H_2O, H_2CO, etc.) remain on the grain and form more complex molecules (in a reaction with an excited radical or after activation by absorption of an ultraviolet photon). Steady thermal evaporation is insufficient to eject the molecules that remain on the surface after reactions and nonequilibrium mechanisms are considered. Photons (1000 to 2000 Å) from unshielded interstellar starlight eject a physically adsorbed molecule in $\sim 10^9$ s. (76 references) (auth)

39325 DISTRIBUTION OF NEUTRAL HYDROGEN IN THE PERSEUS ARM. Perry, John F. W.; Helfer, H. L. (Univ. of Rochester, N. Y.). Astrophys. J.; 174: No. 2, 341-60(1 Jun 1972).

A statistical analysis is applied to 21-cm data to derive models of the density distribution of interstellar gas in small volumes of spiral arms. After subtracting a background model, the density fluctuations are statistically represented by superpositions of randomly located spherical clouds. The expected number of these model clouds per unit volume and their central gas densities are both derived as functions of cloud diameter by a correlation analysis, using a Monte Carlo technique. Many small volumes within four large segments of the Perseus arm and one segment of an interarm feature, each observed with the 140-foot (43 m) telescope and 400-channel receiver at NRAO, are analyzed. The resulting cloud distributions are presented; they vary rapidly between small volumes, but the average distributions over each entire segment are remarkably consistent. The cloud mass spectrum is very well described by a power law $f(m) \propto m^{-\beta}$, with $\beta = 1.75 \pm 0.15$ for the Perseus arm segments and $\beta = 2.0 \pm 0.15$ for the interarm feature, for cloud masses $10^3 \leq m \leq 10^6\ M_\odot$. There is a slight surplus of the smallest clouds on the farther side of the arm. Attempts to obtain relative distances to the segments were partially successful. (38 references) (auth)

39326 TIME-DEPENDENT MODELS OF THE INTERSTELLAR GAS. Jura, M.; Dalgarno, A. (Harvard Coll., Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 174: No. 2, 365-76(1 Jun 1972).

Time-dependent models are presented of the evolution of the interstellar gas following a supernova flash and the results of detailed calculations of the cooling and recombination of the initial hot ionized plasma are described. The calculations confirm the importance of supernova explosions to the thermal and ionization balance of the interstellar medium. Two kinds of models reproduce the gross properties of the intercloud regions. In one, the ionization and heating are produced by an ultraviolet burst but the heating is supplemented by a steady-state source. In the other, the medium is initially partly ionized and heated by an x-ray burst and no other heating source is required. The observational consequence of the models is explored, and calculations are reported of infrared line emissivities, ratios of the intensities of helium and hydrogen radio recombination lines, and interstellar ultraviolet line absorptions. (auth)

39327 ACTIVE GALAXIES WITH RADIO TRAILS IN CLUSTERS. Miley, G. K.; Perola, G. C.; van der Kruit, P. C.; van der Laan, H. (Sterrewacht, Leiden). Nature (London); 237: No. 5353, 269-72(2 Jun 1972).

New radio data and a critical examination of the interacting galaxies hypothesis to explain complex radio sources in clusters leads to rejection of a causal relation between sources in clusters. Instead, the "head–tail" radio galaxies are proposed to represent radio trails of galaxies, active in their own right, along trajectories through a dense intergalactic medium. (auth)

39328 OPTICALLY VARIABLE GALAXY V395 HERCULIS. Bond, Howard E. (Louisiana State Univ., Baton Rouge). Astrophys. J.; 174: No. 3, L163(15 Jun 1972).

The object V395 Herculis appears to be a compact galaxy rather than a galactic star. Extremely rapid optical variations have been reported for this object. It is not known to be a radio source. (auth)

39329 DENSITY DATA AND EMISSION MEASURE FOR A MODEL OF THE COMA CLUSTER. King, Ivan R. (Univ. of California, Berkeley). Astrophys. J.; 174: No. 3, L123-5 (15 Jun 1972).

The density, the square of the density, the velocity dispersion, and the escape velocity are given numerically, in space and in projection, for a model fitted to the Coma cluster of galaxies. The total emission measure is calculated. Lyman-α observations of higher sensitivity will be needed to confirm or dismiss the hypothesis that the "missing mass" is hot gas. (auth)

39330 GENERATING MECHANISM OF SPIRAL STRUCTURE. Lynden-Bell, D.; Kalnajs, A. J. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 157: No. 1, 1-30(1972).

Flat galaxies want to transfer their angular momentum outwards. Only in trailing spiral structures do the gravity torques carry angular momentum outwards. It is shown that the presence of waves lowers the angular momentum in the inner parts and increases it in the outer parts. Further there is absorption of angular momentum by stars that resonate with the wave at the outer Lindblad resonance, and at corotation. Emission of angular momentum occurs at the inner Lindblad resonance. The role of spiral structure is to carry angular momentum from the inner parts to the outer parts so that the waves may grow. Bars in galaxies are considered to be standing waves which have grown enough to orient and trap the major axes of orbits with two lobes so that they lie along the bar. (auth)

39331 STRUCTURE OF SEYFERT NUCLEI. Rees, M. J. (Cambridge Univ., Eng.); Sargent, W. L. W. Comments Astrophys. Space Phys.; 4: No. 1, 7-14(Jan-Feb 1972).

The physical conditions of the gas in Seyfert nuclei are probably exceedingly complex and inhomogeneous. However, all the available spectral data even for NGC 4151 may be explicable in terms of a two-component model: a comparatively tenuous region $\gtrsim$25 pc in size, and a compact region that emits the broad wings. Although the spectral information on the broad wings is very sparse and imprecise, the possible properties of this region are discussed along with the cause of the line broadening. This region is of interest because it may be ultimately linked to the primary energy source. (W.D.M.)

39332 KINEMATICS OF GAS NEAR THE GALACTIC CENTER. Sanders, R. H.; Scoville, N. Z.; Spiegel, E. A. Comments Astrophys. Space Phys.; 4: No. 1, 15-21(Jan-Feb 1972).

Recent developments in the observational studies of the outward flow of gas from the galactic center are summarized, and some possible kinematic conclusions that may tentatively be drawn from them are discussed. (W.D.M.)

39333 PROFILES OF THE HYDROGEN LINES IN NGC 3516 AND NGC 5548. Ulrich, Marie-Helene J. (Univ. of Texas, Austin. Institut d'Astrophysique, Paris). Astrophys. J.; 174: No. 3, 483-8(15 Jun 1972).

Profiles of the Hα line emitted by the nucleus of NGC 3516 and NGC 5548 were obtained from image-tube spectra with a dispersion of 28 Å mm^{-1}. Both Hα profiles were asymmetrical, the short-wavelength side being the more intense. The observed profiles were compared to an electron scattering profile and to the profile caused by an opaque sphere surrounded by an expanding envelope. The comparison led to the following conclusions. In the case of NGC 5548 it has not been possible to discriminate between the expanding-envelope model and a model in which the long-wavelength side of the profile is caused by electron scattering and the short-wavelength side is caused by a cloud moving toward us at a velocity of ~2000 km s^{-1} and a velocity dispersion of ~2000 km s^{-1}. In the case of NGC 3516 the observed profile cannot be explained by electron scattering alone or by the particularly simple case of expanding envelope model which is under consideration. In both nuclei the profiles of the Hα line strongly suggest the presence of mass motions with velocities in the range 1000 to 4000 s^{-1}. The effects of the expansion of the dense gas on the luminosity of the nucleus and on the line profiles are briefly discussed. (auth)

39334 VELOCITY DISPERSIONS IN GALAXIES. I. THE E7 GALAXY NGC 7332. Morton, Donald C.; Chevalier, Roger A. (Princeton Univ., N. J.). Astrophys. J.; 174: No. 3, 489-98 (15 Jun 1972).

A coudé spectrum of the E7 galaxy NGC 7332 with 0.9 Å resolution from 4186 to 4364 Å was obtained with the Princeton SEC vidicon television camera and the Hale telescope. Comparisons with spectra of G and K giant stars, numerically broadened for various Maxwellian velocity distributions, give a dispersion velocity in the line of sight of 160 ± 20 km s^{-1} with the best fit at G8 III. The dispersion appears to be constant within ±35 km s^{-1} out to 1.4 kpc (H = 100 km s^{-1} Mpc^{-1}). After correction for projection, the rotation curve has a slope of 0.18 km s^{-1} pc^{-1} at the center and a velocity of 130 km s^{-1} at 1.4 kpc where it is still increasing. For an estimated effective radius of 3.5 kpc enclosing half the light, the virial theorem gives a mass of 1.4×10^{11} $\mathrm{M}_\odot$ if the mass-to-light ratio is constant throughout the galaxy. The photographic luminosity is 1.0×10^{10} $\mathrm{L}_\odot$ so that the M/L ratio is 14. (auth)

39335 CHARGE-TRANSFER REACTION $C^{+2} + He \rightarrow He^{+} + C^{+}$ AND ITS APPLICATION TO THE INTERSTELLAR MEDIUM. Brown, Robert L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 174: No. 3, 511-16(15 Jun 1972).

The rate coefficient for the charge-transfer reaction $C^{+2} + He \rightarrow C^{+} + He^{+}$ was evaluated at thermal energies T = 10^2 to 10^4 °K within the framework of the "orbiting approximation." The effect of this process on the ratio of number densities $n(C^{+2})/n(C^{+})$ expected in the interstellar medium was used to show that the C III λ977 Å line will be produced preferentially in H I clouds with temperatures $\lesssim$300°K. (auth)

39336 POLARIZATION OF THE DIFFUSE GALACTIC LIGHT. Sparrow, J G.; Ney, E. P. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 174: No. 3, 717-20(15 Jun 1972).

Polarization measurements made from the satellite OSO-5 show that the polarized intensity in the direction of the Scutum arm of the Galaxy is different in intensity and direction of the polarization from that observed due to the zodiacal light. The observations are consistent with polarized diffuse galactic light superposed on the zodiacal light. The results are interpreted in terms of a model in which the galactic starlight is scattered by interstellar dust. (auth)

39337 REDSHIFTS FOR GALAXIES IN AND NEAR ABELL 2147. Bautz, Laura, P. (Northwestern Univ., Evanston, Ill.). Astron. J.; 77: No. 5, 331-2(Jun 1972).

Sixteen galaxies southwest of the Hercules cluster were observed to determine the true spatial arrangement of two apparent arcs of galaxies. Twelve of them, including the peculiar system Arp 324, are projected against the rich cluster Abell 2147. Four are away from the main body of the cluster. All but two of the group have redshifts comparable to galaxies in the Hercules cluster. A 2147 is at roughly the same distance as the Hercules cluster. (auth)

39338 RADIAL VARIATIONS IN THE STRENGTHS OF ABSORPTION FEATURES IN THE SPECTRA OF TWO EARLY-TYPE GALAXIES. Welch, Gary A.; Forrester, William T. (Wesleyan Univ., Middletown, Conn.). Astron. J.; 77: No. 5, 333-41(Jun 1972).

A spectrophotometric study based on image-tube spectrograms was conducted of selected absorption features in the galaxies NGC 3115 (E7/S0) and NGC 4472 (E2). Significant radial variation—in the sense of decreasing strength with distance—occurs in the violet cyanogen bands at λ3883 and λ4216, the G band, the Mg I + MgH blend at λ5175, and the "D" line of neutral sodium at λ5892. A qualitatively consistent interpretation is that the relative abundance of metallic elements and of late dwarf stars is high in the nuclei of these galaxies. In relation to the size of the system the strengths decline much more rapidly in NGC 4472 which may reflect a difference in the stellar velocity distributions within the galaxies. (auth)

39339 GRAVITATIONAL ACCELERATION PERPENDICULAR TO THE GALACTIC PLANE. Gould, Ellen; Vandervoort, Peter O. (Univ. of Chicago). Astron. J.; 77: No. 5, 360-5(Jun 1972).

A new method for the determination of the gravitational acceleration perpendicular to the galactic plane is formulated in terms of a set of virial equations governing the perpendicular structure of a stellar subsystem of the Galaxy. The formulation properly takes account of the facts (often neglected) that the equations of galactic dynamics govern expectation values of observable quantities and that applications of the equations involve replacing those expectation values with observed values in the Galaxy. When applied to a sample of A-type stars in the general direction of the North Galactic Pole, the method yields values in the range 0.19 to 0.28 $\mathrm{M}_\odot \mathrm{pc}^{-3}$ for the density of matter in the solar neighborhood. The apparent discrepancy between this result and the conventional value 0.15 $\mathrm{M}_\odot \mathrm{pc}^{-3}$ is found to be marginal when the statistics of the sample is considered. (auth)

39340 INTERSTELLAR $^{12}C/^{13}C$ RATIOS TOWARD SIX STARS. Hobbs, L. M. (Univ. of Chicago). Astrophys. J.; 175: No. 1, L39-41(1 Jul 1972).

Carbon isotope ratios $a \equiv N(^{12}C)/N(^{13}C)$ were measured for interstellar CH^{+} molecules toward six stars, using the λ4232 line. Negative results of high sensitivity were obtained for the $^{13}CH^{+}$ line in all cases, yielding lower limits from a > 20 to a > 77. (auth)

39341 EQUILIBRIA AND OSCILLATIONS OF A FAMILY OF UNIFORMLY ROTATING STELLAR DISKS. Kalnajs, Agris J. (Harvard Coll. Observatory, Cambridge, Mass. Tel-Aviv Univ., Israel). Astrophys. J.; 175: No. 1, 63-76(1 Jul 1972).

The stability of a family of self-consistent uniformly rotating collisionless stellar disks was investigated by solving the normal mode problem. Every member of the family is unstable. From this family new models were generated that can be either stable or unstable. Two examples of each are given. The two unstable models show that nonaxisymmetric modes can still be unstable after all the axisymmetric instabilities have been suppressed. The most troublesome mode appears to be the barlike elliptical deformation. (auth)

39342 RANDOM GRAVITATIONAL ENCOUNTERS AND THE EVOLUTION OF SPHERICAL SYSTEMS. IV. ISOLATED SYSTEMS OF IDENTICAL STARS. Spitzer, Lyman Jr.; Thuan, Trinh X. (Princeton Univ., N. J.). Astrophys. J.; 175: No. 1, 31-61(1 Jul 1972).

Models of isolated stellar systems with stars all of the same mass were recomputed, allowing for the exact dependence of the velocity diffusion coefficients on stellar velocity, and extending to later evolutionary phases than before. The results show that the inner 10% of the mass collapses to a singularity in a time about equal to 18 t_{rh}, where t_{rh} is the dynamical relaxation time at the mean density inside the median radius r_h during the early life of the system. This behavior is in general agreement with earlier results by Larson. Early in the evolution the energy released by the contracting core goes primarily into stars which accumulate in the outer halo, with some drain also into stars which escape from the system. Toward the end of the development the energy goes into a readjustment of the intermediate regions of the system; this later stage appears unrelated to buildup of the outer halo or to stellar escape but is similar to the "gravo-thermal instability" discussed by Lynden-Bell and Wood. These models permit a comparison of escape rates with a "local" theory, where the velocity distribution function at any point is arbitrarily assumed to be the same as that obtained from the Fokker–Planck equation for a homogeneous system, with a rectangular profile for the potential $\phi(r)$, and where ξ_e, the overall probability of escape per star per interval of time, is computed by averaging over the entire system the local escape probability at each point. The "observed" ξ_e for the isolated systems rises to about 0.3% per time interval t_{rh}, as compared with about 0.8 to 1% predicted by the local theory. If escaping stars are taken to include those which accumulate in the outer halo, which outnumber the true escapers by about two to one at intermediate evolutionary phases, the results from the computer models are in reasonable agreement with the simple theory at these intermediate times. (auth)

39343 ZVEZDY TUMANNOSTI GALAKTIKI. TRUDY SIMPOZIUMA, BYURAKAN, SSSR, 16–19 SENTYABRYA 1968. (Stars, Nebulae, and Galaxies. Transactions of Symposium Held at Byurakan, USSR, September 16–19, 1968. Sobolev, V. V. (ed.). Erevan; Izdatel'stvo AN Armyanskoi SSR (1969). 296p.

This collection of 34 papers is divided into three major categories. Theory of radiation transport deals with photon scattering, resonance radiation transport in an optically thick layer, unstable emission fields, and diffuse reflection of quanta. The second group of papers deals with the physics of variable stars and nebulae, and includes solar flares, shock waves in stellar atmospheres, radio astronomy, and young star development. The remainder of the papers discusses physical processes in galaxies, and includes such topics as relativistic polytropes, Seyfert galactic nuclei, certain special eruptions, and extragalactic objects. (K.S.W.)

39344 POLARIZATION AND VELOCITY FIELD IN THE GALAXY M82. Elvius, Aina (Stockholm Observatory). Astron. Astrophys.; 19: No. 2, 193-6(Jul 1972).

The model of M82 tentatively suggested by Sandage (1971) on the basis of polarization measures in the Hα emission line is discussed. It is pointed out that the assumption of scattering of Hα rather than recombination in the filaments implies a new interpretation of the observed radial velocities. (auth)

39345 SPATIAL INHOMOGENEITIES OF NUCLEOSYNTHESIS. Reeves, Hubert (CEN, Saclay, France. Institut d'Astrophysique, Paris). Astron. Astrophys.; 19: No. 2, 215-23(Jul 1972).

Data on the expansion of supernova remnants (SNR) was used to study the mixing time scale of newly made material to the galactic gas. The distribution of regions where star formation and star explosion takes place, together with the dynamics of the mixing processes suggest the existence of spatial inhomogeneities in the element concentrations of the galactic gas. These inhomogeneities may be reflected in the abundances of fossil radioactivities in the solar system, and perhaps also in the stellar Z abundances. (auth)

Cosmology

Refer also to abstracts 39231, 39732, 39733, and 39738.

39346 (JINR–E2-6392) ON THE LOWER LIMIT OF BOSON MASSES IN A CLASS OF COSMOLOGICAL MODELS. Tagirov, E. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 18p. Dep. NTIS (U. S. Sales Only).

As has been concluded by some authors, bosons cannot exist for which $m^2 < m_0^2 - (h/cr)$, m^2 being the boson rest mass, in the De Sitter universe of radius r, and, consequently, in a certain clsss of cosmological models. The significance of this bound is discussed, and an objection against it is given on the ground of a strict calculation and study of the properties of two-point functions of the quantum scalar field with $m^2 < m_0^2$ and $m^2 > m_0^2$. (auth)

39347 NON-VELOCITY RED SHIFTS AND PHOTON–PHOTON INTERACTIONS. Pecker, J. C. (College de France, Paris); Roberts, A. P.; Vigier, J. P. Nature (London); 237: No. 5352, 227-9(26 May 1972).

Reference is made to the qualitative explanation of galactic redshift anomalies put forward by Hoyle and Narlikar (Nature 233: 41(1971)). A possible alternative explanation in terms of an inelastic photon–photon interaction is discussed. This is stated to be more quantitative and to be testable in the laboratory, and to possess the following important features: First, it accounts also for the unresolved discrepancy in the solar redshift at the limb; second, the average energy-loss parameter derived from the solar data can explain the galactic redshift anomalies in terms of variations in source temperature; third, such a source-dependent effect can explain an anomaly at present unresolved in the distribution of pulsars at high galactic latitudes; and fourth, the sensitivity of present available apparatus allows a laboratory test of the existence of the interactions, at least for incident x rays. Suitable experimental work is suggested. (UK)

39348 DISTANCE–REDSHIFT RELATION FOR UNIVERSES WITH NO INTERGALACTIC MEDIUM. Dyer, C. C.; Roeder, R. C. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 174: No. 3, L115-17(15 Jun 1972).

The distance-redshift relation is derived for model universes in which there is negligible intergalactic matter and in which the line of sight to a distant object does not pass close to intervening galaxies. When fitted to observations, this relation yields a higher value of q_0 than does a homogeneous model. (auth)

39349 MAGNITUDE–REDSHIFT RELATION IN BRANS–DICKE COSMOLOGY. Tinsley, Beatrice M. (Univ. of Texas, Dallas). Astrophys. J.; 174: No. 3, L119-21(15 Jun 1972).

The magnitude–redshift relation expected in a flat Brans–Dicke world is discussed. Effects of stellar evolution, both in the conventional manner and as caused by the time variation of the gravitational constant, are included. (auth)

39350 LIMITS TO THE SUB-MILLIMETRE ISOTROPIC BACKGROUND. Beckman, J. E.; Ade, P. A. R.; Huizinga, J. S.; Robson, E. I.; Vickers, D. G. (Queen Mary Coll., London). Nature (London); 237: No. 5351, 154-7(19 May 1972).

A phase-modulated Michelson interferometer and a He-cooled Rollin photoconductive far-infrared detector, at the focus of a 35-cm-aperture Cassegrain telescope, were flown at 12.1 km from RAE, Farnborough, in a Comet aircraft, in Nov. 1971, and the emission spectrum of the stratosphere was obtained in the wave number range 36 to 5 cm^{-1} (280 μm to 2 mm). An analysis of a portion of this spectrum for features produced by sources outside the Earth's atmosphere is described. Good agreements were found for positions and strengths of O_3 lines with theoretical spectra and for HNO_3 lines with laboratory data and near-infrared atmospheric studies. The spectra showed, qualitatively, the rapid changes in the strengths of the lines as a result of variations in the optical emission path. It is concluded that any submillimetre extra-atmospheric excess of flux of magnitude 10^{-9} W/cm^2/sr, or greater, cannot be reconciled with the data obtained, anywhere between 10 and 25 cm^{-1}, unless it takes the form of a very broad feature, of half-width >3 cm^{-1}. There is also no observational evidence that the isotropic background radiation indicates other than a 3K blackbody continuum. If studies were made at balloon atlitudes of, say, 30 km, the line spectral data presented would be of value in distinguishing atmospheric from extra-atmospheric radiation. (UK)

39351 GALACTIC BACKGROUND AT 15 GHz. Hirabayashi, H. (Tokyo Univ.); Yokoi, H.; Morimoto, M. Nature (London) Phys. Sci.; 237: No. 73, 54-6(22 May 1972).

Observations were made in Nov. 1971 of the galactic background continuum radiation at a frequency of 15 GHz and an angular resolution of 11 arc min. The object was to determine the brightness of the background radiation at a high frequency, where the contribution of the thermal radiation to the total background is larger than at low frequencies, enabling spectral separation of the background radiation into thermal and nonthermal components. For the observations the mm-wave experimental facility at the Ibaraki Satellite Communication Center was employed. Comparisons were made with brightness temperatures obtained at lower frequencies. The spectral index was close to −3.0 for the lower frequencies and approached −2.1 for the higher frequencies. The former value represents the index for the nonthermal radiation, and the latter corresponds to the theoretical value for the thermal radiation. It thus seems that the thermal radiation contributes an important part to the total background radiation, and the observations are regarded as the first positive evidence for thermal radiation in the galactic background continuum. The kinetic temperature of electrons responsible for the thermal continuum and line emission was calculated and, using the electron temperature values and strength of the thermal continuum emission, values were obtained for the emission measure, from which the electron density in the Galaxy was estimated as $\sim 0.5/\mathrm{cm}^3$, a value much higher than derived from pulsar observations. (UK)

39352 CURVED SPACE COSMOLOGICAL BOUNDS ON THE TIME VARIATION OF G. Morganstern, R. E. (Lunar Science Inst., Houston, Tex.). Nature (London) Phys. Sci.; 237: No. 74, 70-1(29 May 1972).

Reference is made to a paper by the present author (Nature 232: 109(1971)) in which a theoretical upper bound was given on the time variation of G ($^{\cdot}\Lambda_0$) as predicted by the Brans–Dicke theory (Phys. Rev. 124: 925(1961)) for Friedmann-type expanding cosmologies in flat space. It was also found that the introduction of pressure resulted in a decrease in the upper bound on $^{\cdot}\Lambda_0$, and it was suggested that this also holds in curved space. Although it is not possible to give a rigorous proof of this without explicit knowledge of curved space solutions, a much more quantitative argument in its favor is advanced in the present paper. Furthermore, it is found that, independent of the exact nature of the cosmological solution, the curvature contribution to $^{\cdot}\Lambda_0$ is of the same order of magnitude as the flat space contribution and adds to it, or subtracts from it, for positive or negative curvatures, respectively. It is concluded that whereas in positively curved space an increase in $^{\cdot}\Lambda_0$ by no more than an order of magnitude from the flat space upper bound may be expected, in negatively curved space the decrease in $^{\cdot}\Lambda_0$ relative to flat space depends critically on the at-present unknown cosmological solutions. A knowledge of these curved-space solutions would give precise meaning to current and future observational bounds on the time variation of the gravitational constant and would seem worthwhile pursuing. (UK)

39353 FIRST FACT OF EVOLUTIONARY COSMOLOGY. Clayton, Donald D. (Rice Univ., Houston, Tex.). Comments Astrophys. Space Phys.; 4: No. 1, 29-33(Jan-Feb 1972).

It is argued that the work of Rutherford and his colleagues on radioactive decays produced the first correct argument for an evolving cosmos—the realization that since uranium still exists it cannot have always existed. (W.D.M.)

39354 OBSERVATION OF THE DIFFUSE COSMIC GAMMA RADIATION IN THE 30- TO 50-MeV REGION. Mayer-Hasselwander, H. A.; Pfeffermann E.; Pinkau, K.; Rothermel, H.; Sommer, M. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astrophys. J.; 175: No. 1, L23-8(1 Jul 1972).

Results of two balloon flights are presented in which a γ-ray astronomy spark chamber was carried to residual atmospheric pressures of 1.7 and 2.2 g cm^{-2}, respectively. A diffuse flux of celestial γ rays was discovered at 30 to 50 MeV which shows no significant correlation with galactic features and which exceeds a linear interpolation between previously known γ-ray data at 1 and 100 MeV by a factor of between 4 and 10. (auth)

39355 EXPECTED DENSITY OF GRAVITATIONAL-LENS QUASARS. Barnothy, J. M.; Barnothy, M. F. Astrophys. J.; 174: No. 3, 477-82(15 Jun 1972).

The expected density of gravitational-lens quasars is adequate, or higher than the observed density. (auth)

39356 ENRICHMENT OF INTERGALACTIC MATTER. Silk, Joseph; Siluk, Richard S. (Univ. of California, Berkeley). Astrophys. J.; 175: No. 1, 1-10(1 Jul 1972).

The primordial gas out of which the Galaxy condensed may have been significantly enriched in heavy elements. A specific mechanism of enrichment is described, in which quasi-stellar sources eject enriched matter into the intergalactic medium. This matter is recycled through successive generations of these sources, and is progressively enriched. The enriched intergalactic matter is accreted by the protogalaxy and it is found, for rates of mass ejection by quasi-stellar sources $\sim 1\ M_\odot$ per year in heavy elements, that this mechanism can account for the heavy-element abundances in the oldest Population II stars. Expressions are given for the degree of enrichment Z of the intergalactic gas as a function of redshift z, and it is shown that the hypothesis implies that the present density of intergalactic gas must be at least a factor 3 larger than the mean density in galaxies at the present epoch. A variation of Z with z is predicted, which can, in principle, be tested when the equivalent widths of a sufficient number of emission and absorption lines in different quasi-stellar sources are available. (auth)

39357 THERMODYNAMICS IN COSMOLOGY. Wataghin, Gleb. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 50: No. 6, 725-9(Jun 1971). (In Italian).

A model of an expanding universe filled with neutrino pairs is described. The origin of the weakly interacting phases of the neutrinos and the photons in the actual universe is analyzed, and the role of rapid-cooling processes of hadrons and of photons at a certain "leptonic" epoch is pointed out. (auth)

39358 ORIGIN OF THE COSMIC MICROWAVE BACKGROUND RADIATION IN A CHAOTIC UNIVERSE. Rees, M. J. (Harvard Coll. Observatory, Cambridge, Mass.). Phys. Rev. Lett.; 28: No. 25, 1669-71(19 Jun 1972).

If the early Universe possessed the maximum degree of irregularity compatible with its present large-scale uniformity and isotropy, dissipation of energy at redshifts $z \gtrsim 10^4$ would have generated a thermal microwave background with present temperature ~ 3°K. (auth)

39359 EXACT SOLUTIONS (PARTICULAR AND GENERAL) OF THE EINSTEIN EQUATIONS FOR SPACE FILLED WITH MATTER. Kuchowicz, B. (Univ., Warsaw). Postepy Astron.; 20: No. 2, 151-4(Apr-Jun 1972). (In Polish).

The most practically important matter distribution for which several exact solutions of the Einstein equations have been obtained is a spherically symmetric distribution of a perfect fluid. Using the isotropic coordinates it was possible to derive a particularly simple form of the general formal solution in the static case. The problem of solving a second-order differential equation is reduced to that of calculating two integrals: $\int v\,dx$ and $\int u\,dx$, with the differential condition: $du/dx = \frac{1}{2}u^2 - v^2$ which must be fulfilled. The general solution can be applied to the derivation of new particular solutions; examples of this are given. (auth)

39360 EQUATION OF STATE AND ADIABATIC STABILITY FOR GENERAL RELATIVISTIC SPHERES. Kuchowicz, B. (Univ., Warsaw). Postepy Astron.; 20: No. 2, 155-58(Apr-Jun 1972). (In Polish).

Matter inside relativistic spheres has to fulfill certain physical conditions (e.g. positive definiteness of density and pressure, stability for static spheres, etc.). The general formal solution for static spheres in isotropic coordinates enables one to present all these conditions in the simple form of differential inequalities containing two functions u and v, which depend on the radial variable r. Also, a general parametric form of the equation of state is obtained. (auth)

39361 SOME REMARKS ON INTERGALACTIC MAGNETIC FIELDS. Rees, M. J.; Reinhardt, M. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 19: No. 2. 189-92(Jul 1972).

Observational upper limits to the strength of intergalactic magnetic fields are discussed. The role such fields might play in the early stages of the hot model of the Universe, and in galaxy formation after the recombination era is investigated. (auth)

Planetary Phenomena

Refer also to abstract 38183, 39621, 39704, and 39724.

39362 INVESTIGATION OF A POSSIBLE SOLAR-WIND DARKENING OF THE LUNAR SURFACE BY PHOTOELECTRON SPECTROSCOPY. Yin, Lo I.; Ghose, Subrata; Adler, Isidore (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res ; 77: No. 8, 1360-7(10 Mar 1972).

Detailed sequential studies by photoelectron spectroscopy of the change in valence states of iron in Fe_2O_3, Fe_3O_4, FeO, and Fe foil samples show that chemical reduction does take place on the sample surface when argon-ion bombardment occurs. These spectra give evidence that, after prolonged ion bombardment, the surface of all four samples consisted predominantly of iron in the metallic state. Argon-ion sputtering of 15 silicate and oxide samples under similar experimental conditions produced surface darkening only in samples containing iron. Monitoring of the photoelectron peak of carbon during the experiment indicated that ion-bombardment darkening is not due to the buildup of hydrocarbon surface contaminants in our oil-free high-vacuum system. On the basis of these studies, it is concluded that solar-wind bombardment should be included as one of the possible mechanisms for producing darkening of the lunar surface. (auth)

39363 DOES IO'S IONOSPHERE INFLUENCE JUPITER'S RADIO BURSTS Webster, David L.; Alksne, Alberta Y.; Whitten, Robert C. (Ames Research Center, Moffet Field, Calif.). Astrophys. J.; 174: No. 3, 685-96(15 Jun 1972).

Goldreich and Lynden-Bell's theory of Jupiter's Io-correlated decametric radiation sets a lower limit to Io's conductivity, high enough to carry the current associated with the radiated power. Dermott's analysis of conductivities of rocks and ice shows no such conductivity at Io's temperature. However, it is shown that if Io has even a small atmosphere, say of methane as suggested by Binder and Cruikshank, or of argon or nitrogen, it will have an ionosphere with adequate conductivity to meet the above criterion. A requirement for higher conductivity was found by Goldreich and Lynden-Bell on the basis of motion of magnetic lines past Io. This requirement appears unnecessary in view of experiments which prove that motion of the lines is not the source of the electromotance. Some results obtained by Drell, Foley, and Ruderman are also used to resolve some further inconsistencies in the Goldreich and Lynden-Bell approach, and to justify use of the dc approximation in treating current flow in the magnetic flux tubes. (auth)

39364 PLASMA PHYSICS OF THE JOVIAN DECAMETER RADIATION. Goldstein, Melvin L.; Eviatar, Aharon (Tel-Aviv Univ., Israel). Astrophys. J.; 175: No. 1, 275-83(1 Jul 1972).

It is assumed that the decameter radiation from Jupiter is produced near the local electron gyrofrequency and is amplified as it propagates out of the Jovian magnetosphere. Using the Vlasov–Maxwell equations, which describe the propagation of radiation in hot collisionless plasmas, the growth rate for radiation that propagates almost perpendicular to the direction of the magnetic field is derived. When the electrons are described by a loss-cone distribution function, the growth rate is large enough to lead to a large amplification factor over a source region of 100 to 4000 km, depending on the choice of parameters. Because low-energy electrons are expected to be trapped in the Jovian dipole field regardless of the position of the satellite Io, it is maintained that this model provides a plausible mechanism for the decametric radiation not associated with Io. (auth)

39365 SCATTERING AND SCINTILLATIONS OF DISCRETE RADIO SOURCES AS A MEASURE OF THE INTERPLANETARY PLASMA IRREGULARITIES. Vitkevich, V. V. (Academy of Sciences, Moscow). Astrophys. Space Sci. Libr.; 29: Pt. II, 49-66(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

It is well known that, as the radio-frequency radiation from distant discrete astronomical source passes through the circumsolar (coronal) plasma and interplanetary plasma (extension of the corona, or the solar wind), it can undergo refraction and sometimes absorption by the (extended) corona as a whole and by larger-scale irregular structures (essentially regions of higher than average plasma density), scattering by smaller irregularities or cells, and scintillation. Observations at various wavelengths with radio telescopes and interferometers (sometimes with networks of instruments) of the radio emission from the discrete sources after passing through the plasma (the "translucent" method) yield such quantities as the intensity I, characteristic scattering angle θ, scintillation index m, characteristic scintillation period τ_0, rms phase shift φ_0, and the transverse component of the velocity of motion of the diffraction pattern V. These quantities are functions of the time and location of the ray relative to the Sun (sometimes expressed as the angular distance or elongation ϵ of the source from the Sun, sometimes as the linear distance r); and all but the last are functions of the wavelength λ. With certain reasonable assumptions, parameters characterizing the irregularities in the plasma structure can be derived, including a characteristic scale size a (or two orthogonal scale sizes a and b for those irregularities that apparently are elongated in shape), the drift velocity of the irregularities u, and the rms electron-density fluctuation ΔN all as functions of heliocentric distances r or elongation ϵ, and the time, including the phase of the solar cycle or immediate level of solar activity. The results are not very sensitive to the assumptions that must be made concerning the thickness of the layer of plasma that dominates the production of the observed phenomena ΔL, the distance to the dominant region Z_0, the temperature T, etc. Results to date are summarized and it is emphasized that the method has not yet been fully exploited. Typically, the characteristic scale size a derived from scintillation ranges from ≈ 30 km too close to the Sun to ≈ 300 km farther out, although the effects of selection imposed by the technique may be present. The rms electron-density fluctuation ΔN, obtained from scattering and scintillation studies, is typically in the range 10^2 to 10^3 cm^{-3} close to the Sun, and smaller farther out, but corresponding to 1 to 10% throughout. The motions of the irregularities are predominantly radial, of the order of 400 km/sec in the ecliptic and apparently lower elsewhere. The irregularities apparently become radially elongated as they move away from the Sun. Assuming that the irregularities are preserved against dissipation by an interplanetary magnetic field, the field strength necessary to accomplish this is of the order of a few gammas or tens of gammas. Structures of larger size ($\approx 10^6$ km), greater density ($\approx 10^7$ cm^{-3}), and higher velocity ($\gtrsim 3 \times 10^3$ km/sec) are observed by other techniques. (auth)

39366 CONFIGURATION OF THE INTERPLANETARY MAGNETIC FIELD. Davis, Leverett Jr. (California Inst. of Tech., Pasadena). Astrophys. Space Sci. Libr.; 29: Pt. II, 32-48(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The idealized basic structure of the interplanetary magnetic field is the familiar spiral wound on a cone whose axis is the solar rotation axis. Variations in the radial velocity of the solar wind produce large scale variations in pitch; slight distortions are also produced by the nonradial component of the solar-wind velocity. The high velocity streams in the solar wind seem to be more significant than magnetic polarity alternation in the sector structure of the interplanetary medium. Superposed on the ideal spiral are a variety of smaller structures. Outwardly propagating non-sinusoidal Alfvén waves with scale lengths of order 10^5 to 10^7 km are common; their characteristics and relation to the high-velocity solar-wind streams are examined in some detail. When sharp crested, they are recognized as rotational discontinuities. Other, less easily identified, waves are present part of the time. Tangential discontinuities and other convected structures have been identified, as have interplanetary shock waves. (auth)

39367 INTERACTION OF THE SOLAR WIND WITH THE MOON. Ness, Norman F. (Univ., Rome). Astrophys. Space Sci. Libr.; 29: Pt. II, 159-205(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

During its orbit about the Earth, the Moon is located in the interplanetary medium or in the geomagnetosheath–geomagnetotail formed by the solar-wind interaction with Earth. In the tail no evidence is found for a lunar magnetic field, that limits its magnetic moment to 10^{20} Gcm^3 ($\sim 10^{-6}$ Earth). In the interplanetary medium, no evidence exists for a bow shock or a trailing shock, although a well defined plasma wake region is observed in the anti-solar-wind direction (i.e., downstream). The Moon absorbs the solar-wind plasma that strikes its surface and creates a void region or cavity in the flow. Small perturbations of the interplanetary magnetic field magnitude (<30%) and direction (<20°) are observed to be correlated with the location of the solar-wind plasma umbra and penumbra. Characteristic perturbations in magnitude alternate in sign (+−+−+) as a satellite traverses the wake region. The magnitude of the anomalies is correlated principally with the diamagnetic properties of the solar wind, as measured by β, and less with the direction of the interplanetary magnetic field. The observed lunar Mach cone gives evidence for the anisotropic propagation of waves in the magnetized collisionless warm plasma of the solar wind. Neither the Gold–Tozer–Wilson mechanism of accretion of field lines or the Sonett–Colburn–Hollweg mechanism of unipolar induction is significant in the interaction. The transmission of microstructural discontinuities in the interplanetary medium past the Moon shows little distortion, indicating a low effective electrical conductivity ($\lesssim 10^{-4}$ mho/m) that implies a relatively cool interior ($\sim 10^3$K) of the lunar body. Fluctuations of the interplanetary magnetic field upstream from the plasma wake are stimulated by the disturbed conditions in that region. The Moon behaves like a cold, non-magnetic, fully absorbing dielectric sphere in the solar-wind flow. (65 references) (auth)

PHYSICS (ATMOSPHERIC)

39368 EXPERIMENTAL RESULTS ON THE CHERENKOV PULSES OF EAS. Bosia, G.; Castgnoli, C.; Marangoni, G.; (and others) (CNR, Turin. Univ., Turin). Nuovo Cim.; 9B: No. 2, 177-200(11 Jun 1972).

Experimental results on the temporal distributions of the Cherenkov light from EAS, detected by using very fast techniques, are reported. The values obtained of rise time and pulse width are analyzed, and they agree with the results previously given. Besides, the shapes of the pulses are analyzed in detail. Results concerning a number of abnormal pulses observed during the measurements are also reported and discussed. (auth)

Auroral and Ionospheric Phenomena

Refer also to abstract 40039.

39369 (IPP-VI-102) ION DISSIPATION IN HIGH MACH NUMBER OBLIQUE SHOCKS. Biskamp, D.; Welter, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 32p. Dep. NTIS (U. S. Sales Only).

Numerical simulations have provided detailed information of the microscopic processes that occur in a high-Mach-number oblique shock wave such as the bow shock. The gross feature of the ion dissipation is a strong interaction of the reflected ions with the whistler precursor, which can be explained by a nonlinear ion—ion counterstreaming instability. The instability simultaneously amplifies the magnetic oscillations of the whistler which supports the strong magnetic turbulence at the bow shock. In addition, electrostatic substructures were observed that significantly enhance the thermalization of the ion distribution on the Debye scale. (auth)

39370 (WRE-TN-A-199(AP)) IONOSPHERIC TILTS IN THE F REGION IN THE ABSENCE OF SPREAD F NEAR THE MAGNETIC EQUATOR. Treharne, R. F. (Weapons Research Establishment, Salisbury (Australia)). May 1971. 16p. Dep. NTIS (U. S. Sales Only).

Observations of the Bramley and Ross type of the ionospheric tilt were made near the magnetic equator. During daytime these observations are hindered by the presence of the intense irregularities in the E region, but these tilts do appear to be larger and to have a bias not seen in temperate latitudes; this bias reverses in direction at sunset. During the evening, if spread F is absent, the tilts of the F region may be observed clearly; these show tilts of much greater magnitude and bias, having a much slower time scale than in temperate latitudes. An attempt is made to relate the evening tilts to the post sunset rise in the height of the F region that is observed elsewhere near the magnetic equator, but the only point of agreement is that the times of maximum tilt and of maximum height are coincident. The direction of maximum tilt varies from night to night. (auth)

39371 PROPAGATION AND APPLICATION OF WAVES IN THE IONOSPHERE. Yeh, K. C.; Liu, C. H. (Univ. of Illinois, Urbana). Rev. Geophys. Space Phys.; 10: No. 2, 631-709(May 1972).

The propagation of waves, especially radio waves in the ionosphere, is reviewed. In the macroscopic electromagnetic theory, the mathematical structure of wave-propagation problems depends entirely on the properties of the dielectric operator in a magnetically nonpermeable medium. These properties can be deduced from general discussions of symmetry and considerations of physical principles. When the medium is specifically the ionosphere, various physical phenomena may occur. Because of a large number of parameters, it is desirable to define a parameter space. A point in the parameter space corresponds to a specific plasma. The parameter space is subdivided into regions whose boundaries correspond to conditions of resonance and cutoff. As the point crosses these boundaries, the refractive-index surface transforms continuously. The medium in which the propagation takes place may influence the wave in many different ways. (auth)

39372 ATMOSPHERIC WAVES AND THE IONOSPHERE. Beer, Tom (Univ. of Ghana, Legon). Contemp. Phys.; 13: No. 3, 247-71(May 1972).

The Earth's atmosphere is a fluid that is capable of supporting wave motions whose amplitudes grow with height. A review is presented of some of the evidence for the existence of these waves and a simple theoretical approach for describing them is outlined. A description is included of the studies that have been made dealing with the interaction between the ionization and the atmospheric waves believed to exist at ionospheric heights—namely acoustic waves, evanescent waves, and internal atmospheric gravity waves. (auth)

39373 EXPERIMENTAL EVIDENCES FOR A TRANSIENT ION LAYER FORMATION IN CONNECTION WITH SUDDEN IONOSPHERIC DISTURBANCES IN THE HEIGHT RANGE 20 TO 50 km. Rose, G. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.); Widdel, H. U.; Azcarraga, A.; Sanchez, L. Planet. Space Sci.; 20: No. 6, 871-6(Jun 1972).

Results of four rocket flights in which the height profile of charged carrier concentration was measured suggest that a transient ion layer is formed below 50 km with a maximum in stratospheric height levels (18 to 35 km) during or shortly after SID events. Furthermore, it was shown experimentally that the current measured with rocket-borne Langmuir probes is predominantly caused by free electrons in heights over 63 km. (auth)

39374 EXPERIMENTAL EVIDENCE OF AN ELECTRON TEMPERATURE ENHANCEMENT IN THE WAKE OF AN IONOSPHERIC SATELLITE. Samir, Uri (Univ. of Michigan, Ann Arbor. Tel-Aviv Univ., Ramat-Aviv, Israel); Wrenn, G. L. Planet. Space Sci.; 20: No. 6, 899-904(Jun 1972).

A study of electron temperature (T_e) measurements made by a Langmuir probe mounted on the skin of the Explorer-31 satellite indicates that electron temperature in the very near wake exceeds that of the ambient electron gas. Potential causes of such an enhancement are mentioned but the possibility that the wake temperatures reflect the existence of non-Maxwellian energy distributions cannot be discounted. The results are compared with observations from the Gemini/Agena wake experiment and are found to be in reasonable agreement. (auth)

39375 N_2 POSITIVE AND N_2^+ BAND SYSTEMS AND THE ENERGY SPECTRA OF AURORAL ELECTRONS. Shemansky, D. E.; Donahue, T. M.; Zipf, E. C. Jr. (Univ. of Pittsburgh). Planet. Space Sci.; 20: No. 6, 905-17(Jun 1972).

The relative emission rates of the auroral N_2 positive and N_2^+ band systems can be used to limit the permissible range of differential electron fluxes in auroras, due to remarkable differences in electron excitation functions for the two kinds of systems. Use of recently measured electron cross sections and many observational data from ground based and rocket studies shows that the results are consistent with spectra equivalent to a power law $E^{-1.4}$ for primaries and secondaries combined. The unified primary spectra of Rees (1969) and secondary spectra of Rees et al. (1969) fail seriously to predict the optical ratios. It is shown that Rees' primary spectrum is deficient in slow primaries owing to the use of defective Monte Carlo results of Maeda (1965). Doubt is thereby cast on the validity of experimental results for the differential spectrum below 50 eV reported by Feldman et al. (1971) because of the rapid decrease in flux with energy shown by those measurements. (auth)

39376 MOTION OF A CHARGED PARTICLE INTERACTING WITH A PLANE ELECTROMAGNETIC WAVE PROPAGATING AT AN ARBITRARY ANGLE TO A UNIFORM MAGNETIC FIELD. Woolley, M. L. (Univ. of Sussex, Brighton, Eng.). Plasma Phys ; 13: No. 12, 1141-51(Dec 1971).

The relativistic equations of motion of a charged particle moving in the field of a plane electromagnetic wave which is propagating at an arbitrary angle to a uniform magnetic induction are considered. It is shown that a system of coordinates exists with respect to which the behavior of the perpendicular component of the particle velocity, as a function of the component parallel to the uniform field, can be characterized by a family of ellipsoidal surfaces in the velocity space and that this family is invariant with respect to coordinate transformations which preserve the axial symmetry of the uniform field. (auth)

39377 PLASMA MODELS OF THE TOPSIDE IONOSPHERE AND ELECTROSTATIC WAVE PROPAGATION. Fang, M. T. C.; Andrews, M. K (Imperial Coll. of Science and Tech., London). J. Plasma Phys.; 6: No. 3, 567-77(Dec 1971).

The circumstances under which certain plasma dispersion equations may be used in electrostatic ray tracing problems connected with studies of ionospheric topside plasma resonances are investigated. Three plasma "models" of increasing complexity are compared with each other. The models are based on the assumption of: (i) an adiabatic process with a scalar pressure, (ii) a fully adiabatic process, and (iii) an electrostatic kinetic description. (auth)

39378 PROPAGATION OF PLASMA WAVES NEAR MULTIPLES OF THE ELECTRON GYROFREQUENCY. Andrews, M. K.; Fang, M. T. C. (Imperial Coll. of Science and Tech., London). J. Plasma Phys.; 6: No. 3, 579-87(Dec 1971).

The dispersion relation for electrostatic plasma waves propagating at frequencies near the electron cyclotron harmonics was evaluated and used to determine the refractive index curves for varying values of the angle between the k vector and the ambient magnetic field in a warm magnetoplasma. It is shown that, under certain circumstances (which are defined), the curves have the characteristic "nose" shapes that are necessary to provide a reflexion in the ambient plasma. Thus, the oblique echo reflexion mechanism, which accounts for the appearance of the resonance signals or "spikes" at the plasma and upper hybrid frequencies and on topside ionograms, may also be applied to the plasma waves propagating at frequencies near the electron gyroharmonics. (auth)

39379 CORRELATION OF SOLAR RADIO BURSTS AND SUDDEN INCREASES OF THE TOTAL ELECTRON CONTENT (SITEC) OF THE IONOSPHERE. Matsoukas, D. A. (Boston Univ.); Papagiannis, M. D.; Aarons, J.; Klobuchar, J. A. J. Atmos. Terrest. Phys.; 34: No. 7, 1275-83(Jul 1972).

Using as a guide AFCRL data of solar radio bursts with flux densities S > 500 flux units in the range 245 to 35,000 MHz, a search was made for sudden changes in total electron content (TEC) of the ionosphere. Both the radio burst and the TEC data used in this study were obtained at the AFCRL Radio Observatory at Sagamore Hill. From 2 years of data it was found that 19 cases showed clearly a sudden increase of the total electron content (SITEC) of the ionosphere. Radio bursts with peak flux density in the decimeter range (type G) showed no correlation with SITEC events. Approximately 50% of all the radio bursts that had a peak flux density S > 500 f.u. in the centimeter range showed SITEC's. The percentage increased with increasing peak flux density. The correlation was higher for flare events which occurred within 45° from the central meridian of the solar disc, but it was lower for events that occurred in the early morning hours. The probability reaches nearly 100% when the flare event appears within 45° of the central meridian of the Sun, occurs at local noon or in the early afternoon, and has a peak flux density S > 1000 f.u. in the centimeter range. (auth)

39380 INTERPRETATION OF IONOSPHERIC RADIO DRIFT MEASUREMENTS. IV. THE EFFECTS OF SIGNAL COUPLING AMONG SPACED SENSOR CHANNELS. Fedor, L. S.; Plywaski, W. (National Oceanic and Atmospheric Administration, Boulder, Colo.). J. Atmos. Terrest. Phys.; 34: No. 7, 1285-1303(Jul 1972).

It is shown that the results of temporal correlation analysis of signals obtained in the spaced-receiver method of measuring ionospheric motions can be seriously affected by antenna-to-antenna coupling. The coupling can increase or decrease the computed drift speed depending upon properties of the incident signal and upon the complex coupling coefficients among the antennas, but in typical experimental systems erroneously low speeds may predominate. Velocity errors of 50% can result from system coupling levels of 20 dB. A practical procedure for measuring system coupling is illustrated. The drift speed obtained by the closely-spaced antenna method cannot be considered reliable without such calibration. The principles developed here apply generally to correlation analyses of spaced sensor measurements. (auth)

39381 MAGNETIC CONTROL OF THE LOWER IONOSPHERIC ABSORPTION AT LOWER LATITUDES. Ganguly, S.; Khastgir, S. R. (Bose Inst., Calcutta). J. Atmos. Terrest. Phys.; 34: No. 7, 1261-73(Jul 1972).

The medium-frequency A_1-absorption over Calcutta (geomagnetic latitude 12°15'N) was found to have Sq- and S_D-current control. A weak negative correlation between absorption and magnetic activity is explained in terms of significant drift of ionization prevalent in the absorbing region. A detailed superposed epoch analysis of the absorption data of Colombo and Alma-Ata also reveals negative correlation between absorption and magnetic activity in the early phase. This is followed by the so-called "delayed effect" afterwards, the time-lag of the delay being around 3 to 4 days for Alma-Ata and 7 to 8 days for Colombo. (auth)

39382 DISPERSIVE MOTIONS IN THE IONOSPHERE. Jones, D. (ESTEC, Noordwijk, Netherlands); Maude, A. D. J. Atmos. Terrest. Phys.; 34: No. 7, 1241-59(Jul 1972).

The presence of dispersive motions in the ionosphere would be expected to have an important effect on drift results obtained using conventional methods of analysis. A number of dispersion analysis results for the E region showing marked dispersion is presented, and comparisons are made with the results of conventional analysis methods. In particular, it is shown that in the cases considered, the full correlation method has no advantage over the similar fades method as far as the determination of the velocity vector is concerned. It is also shown that a measure of the skew angle θ of the cross-correlation curve is not a reliable test for the presence of dispersion. From the dispersion-analysis results now accumulating, it is possible that surface gravity waves could be the cause of dispersion in the D and E regions. In the F regions, on the other hand, the dispersion may possibly be caused by a number of diffracting screens at different heights. (auth)

39383 WINTER ANOMALY OF IONOSPHERIC ABSORPTION. Lastovicka, J. (Geophysical Inst., Prague). J. Atmos. Terrest. Phys.; 34: No. 7, 1233-9(Jul 1972).

The lf A3-absorption measurements made at the Průhonice Observatory on 272 kHz were analysed in order to obtain some information concerning the winter anaomaly of the ionospheric absorption. The lower boundary of the winter anomaly is estimated to be about 84 to 85 km. Using new data on the seasonal variation of the collision frequency (Taubenheim, 1971), an improved explanation of the winter anomaly is proposed. Above about 84 to 85 km there is the background winter enhancement of absorption due to a considerably enhanced collision frequency. Days or groups of days of excessive absorption due to the sudden enhancement of the electron density are added to the background absorption enhancement. (auth)

39384 FREQUENCY SHIFTS OF IONOSPHERIC nf_H RESONANCES. Benson, R. F. (Goddard Space Flight Center, Greenbelt, Md.). J. Atmos. Terrest. Phys.; 34: No. 7, 1201-14 (Jul 1972).

The Alouette-II resonances observed near the harmonics of the electron cyclotron frequency f_H reveal frequency shifts (relative to the nf_H values derived from model field calculations) that can be consistently interpreted in terms of plasma-wave dispersion effects superimposed on a positive offset of several kilohertz in the Alouette-II sounder transmitter frequency and a negative offset of a few tens of gammas in the Earth's magnetic field $|B|$ (relative to the model field under quiet conditions near the magnetic equator). Plasma-wave dispersion effects are observed on the $2f_H$ resonance when it is in the vicinity of the resonance observed near the upper hybrid frequency f_T. The $2f_H$ resonant frequency shift is positive when $f_T < 2f_H$ and negative when $f_T > 2f_H$. The observed shift is more than an order of magnitude greater than that expected from a matching of the group velocity of longitudinal plasma waves propagating perpendicular to B, to the component of the satellite velocity perpendicular to B. The observations suggest that an oblique echo model may be required to give a proper interpretation of the $2f_H$ resonance. Comparing the frequency shifts observed near f_T with theory indicates that cyclotron damping can be ignored only when the angle between the propagation vector k and the direction perpendicular to B is less than a few degrees for the $2f_H$ wave, and less than a few tenths of a degree for the nf_H waves with n > 2. The large positive frequency shifts previously attributed to the Alouette-II f_H and $2f_H$ resonances can be explained by assuming a positive instrumental frequency offset. The negative offset of $|B|$ inferred from the plasma resonance observations is consistent with expectations based on recent OGO-3 and OGO-5 rubidium magnetometer observations at higher altitudes in the equatorial regions. (auth)

39385 REAL HEIGHT VARIATIONS OF THE IONOSPHERIC F2-LAYER ABOVE SOME PAIRS OF GEOMAGNETICALLY CONJUGATE STATIONS. Petelski, E. F. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 34: No. 7, 1163-70(Jul 1972).

It is usually assumed that electric potentials at geomagnetically conjugate points are balanced because of the high conductivity along the magnetic-field lines. Therefore ionospheric movements caused by electric fields should be correlated at conjugate points. Subtracting wind-generated movements from the observed total movements it should thus be possible to estimate at what times and to what extent electric fields are effective in the ionosphere. For this purpose six pairs of conjugate stations were chosen. Real-height variations of the F2 layer above these stations were deduced for magnetically quiet days in equinoctial and solsticial months. The experimental data is compared with theoretical results based on global wind theories. It appears that there do exist considerable electric fields that give rise to equivalent ionospheric height variations above closely conjugate points with equal declination effects. (auth)

39386 FLUCTUATIONS OF WATER VAPOUR CONTENT IN THE TROPOSPHERE AS DERIVED FROM INTERFEROMETRIC

OBSERVATIONS OF CELESTIAL RADIO SOURCES. Hinder, R. (Cavendish Lab., Cambridge, Eng.). J. Atmos. Terrest. Phys.; 34: No. 7, 1171-86(Jul 1972).

Observations of extra terrestrial radio sources with ground-based microwave interferometers provide evidence upon irregularities of refractive index that occur in the troposphere. A detailed analysis of observations made with the Cambridge One-Mile Telescope is presented and interpreted in the light of meteorological considerations. The irregularities are due principally to regions of air having a higher water-vapour content than their surroundings and lateral scales of several hundred metres. They are produced by convection and move with the wind at a height of between 1 and 2 km above ground level. Occasionally the variations can be seen in close association with fair-weather cumulus clouds, but they also occur in clear air. (auth)

39387 EQUATORIAL SPORADIC E AND PLASMA INSTABILITIES. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Nature (London) Phys. Sci.; 237: No. 74, 73-5(29 May 1972).

Some unusual features of radio reflections from the sporadic-E region of the ionosphere within a narrow range of latitudes over the magnetic equator are discussed, suggesting an association between equatorial E_s and equatorial electrojet currents. The time of first appearance of E_s in the morning and the time of its disappearance in the evening has been shown to be controlled by the age of the Moon, and this finding has been related to variations of the equatorial electrojet. During simultaneous observations of the H component of the magnetic field, and E_s and E−W electron drifts at stations within the equatorial electrojet region it was found that abnormally large decreases of H during the daytime are associated with simultaneous disappearances of E_s and a reversal of the direction of ionospheric drift; this was attributed to temporary reversal of the currents in the equatorial electrojet. Examples are shown of ionograms from equatorial stations. Amongst conclusions reached are that the sporadic E at equatorial latitudes occurs at the base of the E region and not at the level of maximum electron density. Radar echoes from ionospheric irregularities associated with E_s are discussed, and it has been suggested that the scattering of hf radio waves is due to electron fluctuation consequent on the two-stream instability occurring when there is sufficient relative drift of electrons through the ions and that this must be greater than the ion acoustic velocity. Two types of ionospheric irregularities are discussed, both giving radar echoes, one type giving signals predominating at 16 MHz, whereas only the other type is observed at 146 MHz. (UK)

39388 NONLINEAR WHISTLER PROPAGATION THROUGH THE IONOSPHERE. Buti, B.; Tripathi, V. K. (Indian Inst. of Tech., New Delhi). Radio Sci.; 7: No. 2, 269-73(Feb 1972).

The field-strength dependence of the damping coefficient of whistlers is studied in the geometrical optics approximation in the two limiting cases: (1) weak collisions where $(\omega - \omega_e)^2 \gg \nu^2(\omega, \omega_e$, and ν being the wave, electron cyclotron, and electron−neutral collision frequencies, respectively) but with no restriction on the nonlinearity parameter; (2) strong collisions where $\nu^2 \gg (\omega - \omega_e)^2$ and the nonlinearity parameter is very high. The nonlinear effects are found to be very important at low frequencies as well as at frequencies near the electron cyclotron frequency. (auth)

39389 THEORY OF SCATTERING FROM IRREGULARITIES IN A MAGNETO-IONIC MEDIUM. Simonich, D. M.; Yeh, K. C. (Univ. of Illinois, Urbana). Radio Sci.; 7: No. 2, 291-9(Feb 1972).

A theory is developed to describe scattering from irregularities in a magneto-ionic medium. The theory makes use of the asymptotic Green's dyadic. Since the medium is anisotropic, cross-mode scattering in addition to self-mode scattering is possible. Several examples are given. (auth)

39390 VLF PHASE CHANGES PRODUCED BY PARTICLE PRECIPITATION INTO THE GEOMAGNETIC ANOMALY DURING SOLAR PROTON EVENTS. Mendes, A.; Ananthakrishnan, S. (Mackenzie Univ., Sao Paulo, Brazil). Radio Sci.; 7: No. 4, 465-8(Apr 1972).

Solar protons in the events of August 28 and September 2, 1966, produced phase disturbances on the 21.4-kHz vlf transmission from station NSS, Annapolis, Maryland, to São Paulo, Brazil, and also on the 26.1-kHz vlf transmissions from station NPM, Hawaii, to São Paulo, Brazil. Both these paths lie well below the polar zone, but partially traverse the geomagnetic anomaly. A quantitative connection between the observed phase advances and satellite observations of the proton flux is used to calculate the length of path affected and the height changes in the disturbed portion of the waveguide. The vlf variations are accounted for by exponential ionospheric models with a reference height equal to the effective reflecting height of the sharply bound model. (auth)

39391 MEASUREMENT OF E-LAYER EFFECTIVE RECOMBINATION COEFFICIENT DURING SOLAR FLARES. Wagner, L. S. (Naval Research Lab., Washington, D. C.); Thome, G. D. Radio Sci.; 7: No. 4, 469-80(Apr 1972).

Simultaneous measurements of flare-enhanced electron density in the E layer and of flare-enhanced solar x-ray flux were used to evaluate the ionospheric relaxation time constant at E-layer heights. The method is an extension of Appleton's ionospheric "filter" idea to the case in which radiation flux and electron-density fluctuations are simultaneously measured. Electron-density measurements were made using the Thomson scatter technique at the National Astronomy and Ionosphere Center, Arecibo, Puerto Rico. X-ray flux data in the 2- to 12-Å band were obtained from instruments aboard the Explorer-33 satellite. Measured values of time constant were converted to an effective recombination coefficient using the familiar Appleton formula and known values of the ambient electron density. Values for the effective recombination coefficient of the order 10^{-7} cm^3/sec were obtained at E-layer heights. (auth)

39392 EXCITATION OF PARAMETRIC INSTABILITIES BY RADIO WAVES IN THE IONOSPHERE. Fejer, J. A.; Leer, Egil (Univ. of California, San Diego, La Jolla). Radio Sci.; 7: No. 4, 481-91(Apr 1972).

The excitation of parametric instabilities by radio waves in a magnetoplasma is discussed. A uniform medium is assumed and linear approximations are used. Excitation by a pump wave of ordinary polarization is hardly affected by the magnetic field. Low- or zero-frequency ion waves and high-frequency Langmuir waves are excited simultaneously. For an extraordinary pump wave, the excited high-frequency electrostatic waves are in the Bernstein mode. The threshold is slightly higher and excitation can occur only within certain "allowed" frequency bands. A new type of parametric instability in which the excited waves are electromagnetic in nature and which is more strongly affected by the inhomogeneous nature of the medium is discussed qualitatively. (auth)

39393 PLASMA TRANSPORT IN THE EQUATORIAL F REGION. McClure, J. P. (Univ. of Texas, Dallas); Peterson, V. L. Radio Sci.; 7: No. 5, 539-47(May 1972).

From simultaneous observations of vertical drift velocity and electron concentration near the dip equator, the photoionization and chemical loss rates for the electrons are deduced. At 300 km, $q = 200$ to 400 ion-pairs cm^{-3} sec^{-1}, and $\beta = 2$ to 4×10^{-4} sec^{-1}. The horizontal plasma transport term of the continuity equation is derived and compared with the corresponding vertical transport term. These terms dominate the electron concentration profiles above 500 km. (auth)

39394 AMPLITUDE PROBABILITY DISTRIBUTION OF RADIO WAVES REFLECTED FROM TRAVELING IONOSPHERIC DISTURBANCES. Srivastava, S. K.; Pradham. S. M.; Tantry, B. A. P. (Banaras Hindu Univ., India). Radio Sci.; 7: No. 5, 563-9(May 1972).

The amplitude distributions of reflected radio waves, from various portions of traveling ionospheric disturbances (TID) superimposed on small-scale irregularities, have been studied with the help of simultaneous records of amplitude and phase patterns of vertically reflected echoes. Amplitude distributions of reflected waves, related to different small portions of TID, are found to exhibit different types of well-known distributions, like Rayleigh, Rice and displaced Gaussian, while resultant distributions corresponding to two successive small portions of the TID may have different shapes, including the familiar M shape reported by many workers. Further, in some events, even three-peaked amplitude distributions are observed depending upon the ratio of steady component to random component present in the received echo and the nature of the reflecting surface. (auth)

39395 EMPIRICAL CONNECTION OF RIOMETER ABSORPTION TO SOLAR PROTONS DURING PCA EVENTS. Potemra, T. A. (Johns Hopkins Univ., Silver Spring, Md.). Radio Sci.; 7: No. 5, 571-7(May 1972).

Linear relationships between daytime 30-MHz polar-cap absorption and the square root of integral and differential proton fluxes have been studied experimentally, using satellite and riometer measurements, and theoretically, by means of power-law model proton spectrums together with D-region ionization models developed previously. Relationships of riometer absorption, A, to the 2π omnidirectional integral proton fluxes greater than the threshold energy E_0 were found to be least sensitive to varying model proton spectrums for $E_0 = 7$ MeV. In this case the following formula was computed: $A = 0.083[J(>7 \text{ MeV})]^{1/2}$ db, where the flux units are cm^{-2} sec^{-1}. Using data collected from the 2π omnidirectional integral proton detectors on the polar-orbiting satellite 1963 38C with $E_0 = 2.2$, 8.4, and 25 MeV on

93 passes and polar-cap 30-MHz riometer data during three markedly different events, the best linear correlation was found to be $A = 0.084[J(>8.4 \text{ MeV})]^{1/2}$ db with a root-mean-square deviation of 0.38 db. Daytime 30-MHz absorption during PCA's is affected most by 15 MeV protons, which produce their greatest ionization at a 65 km altitude in the D region. (auth)

39396 VISIBLE LIGHT FLUX AFFECTING THE D LAYER. Gassmann, G. J.; Wagner, R. A. (Air Force Cambridge Research Labs., Bedford, Mass.). Radio Sci.; 7: No. 5, 613-15(May 1972).

An earlier experimental result of potential importance to D-region chemistry and based on the effect of the Earth's albedo was re-examined and reconfirmed by presenting more detailed technical information on the airborne techniques employed. The interpretation of the observations, which consisted of radio soundings, suggests that the energy flux of visible light, distinct from the uv and x-ray range, has a profound effect on the electron density of the D layer. (auth)

39397 CHANGES IN INTENSITY OF EXCESS RADIATION AT HEIGHTS OF 250 TO 500 KM. Golovii, B. M.; Konyakhina, S. S.; Kurnosova, L. V.; (and others). Kratk. Soobshch. Fiz.; No. 11, 26-32(Nov 1971). (In Russian).

A brief description is given of the flight of Kosmos 225, the apparatus aboard for detecting charged particles, solar flares, and magnetic storms in June 1968 that occurred and were recorded by Kosmos 225. Data recorded by a Cherenkov-scintillation telescope included 600-MeV protons and 40-MeV electrons and showed an extreme irregularity of the appearance of particles with time. There was no particular indication of an increase in intensity of electrons ≥ 0.28 MeV at the heights of 250 to 500 km. (K.S.W.)

39398 NOCTILUCENT CLOUDS. International Symposium, Tallinn, USSR, March 15–18, 1966. Khvostikov, I. A.; Witt, G. (eds.). Moscow; All-Union Institute of Scientific and Technical Information (1967). 236p. (In Russian and English). (CONF-660347).

This volume contains 28 papers and 1 abstract. The papers are in English, supplemented by short abstracts in Russian; the abstract is for a paper presented by L. R. Pitwell entitled "Observations of Clouds Around the Northwestern Shores of the Indian Ocean." The papers are grouped under the following headings: (1) climatology of noctilucent clouds; (2) optical properties of noctilucent clouds: study of aerosol layers; (3) humidity measurements in the mesosphere: rocket-born studies of properties of noctilucent cloud particles; (4) physics of noctilucent clouds: their nature; and (5) morphology and dynamics of noctilucent clouds. (L.M.T.)

39399 ALTITUDES OF THE λ6300-, λ5577-, AND λ4278-A EMISSIONS OF THE STABLE AURORAL RED ARCS OF MARCH 8–9, 1970. Smith, L. L. (Battelle Memorial Inst., Richland, Wash.); Hoch, R. J.; Owen, R. W.; Hernandez, G.; Marovich, E. J. Geophys. Res.; 77: No. 16, 2987-96(1 Jun 1972).

Photometric observations were made from Rattlesnake Mountain, Richland, Washington and Fritz Peak Observatory, Boulder, Colorado of the March 8–9, 1970 stable auroral red arc. The altitudes of the λ6300-, λ5577-, and λ4278-A emissions were determined using the triangulation technique. This is the first event in which the λ5577 arc was observed simultaneously from two stations permitting triangulation. The λ4278-arc observation at Richland is the first observation reported where this emission was associated with the SAR. The observations of λ5200 (N I) emission associated with the λ6300 arc reported are unusual. Thus, it is consistent with the present observations that the low λ5577 and λ4278 emissions were due to some essentially separate mechanism which, in this case, happened to be superposed on an otherwise typical SAR. The fact that the λ6300 emission changed continuously in intensity and altitude as the λ5577 and λ4278 emissions waned seems to indicate that the emissions were all part of a common excitation process that changed character as the event evolved. (J.C.W.)

39400 POLARIZATION OF THE AURORAL ELECTROJET. Coroniti, F. V.; Kennel, C. F. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 16, 2835-50(1 Jun 1972).

An idealized model of electrojet polarization is considered. Precipitation from the inner edge of the electron plasma sheet creates a density maximum in the auroral-oval ionosphere, which in turn leads to Hall and Pedersen conductance maximums. It is then assumed that a uniform westward convection electric field is imposed on the lower ionosphere before polarization. Field-aligned currents must flow into the ionosphere equatorward and out of the ionosphere poleward of the Hall conductance maximum. As the convection field and ionospheric density increase during the substorm growth phase, the field-aligned current densities should eventually reach an instability threshold beyond which anomalous resistance should produce field-aligned electric fields. The partial blockage of the field-aligned currents produces an equatorward electric field and therefore a partial Cowling conductivity in the lower ionosphere. Rough numerical estimates indicate that the expected field-aligned currents can exceed the stability threshold estimated by Kindel and Kennel (1971), that 1- to 5-kV field-aligned potential drops correspond to significant electrojet enhancement, and that the required energy dissipation of field-aligned currents in the topside ionosphere, a few ergs/cm^2 sec column, suggests significant topside modification following auroral breakup. (auth)

39401 SOME IMPLICATIONS OF SATELLITE SPIN EFFECTS IN CYLINDRICAL PROBE MEASUREMENTS. Miller, Nathan J. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 16, 2851-61(1 Jun 1972).

In situ measurements of ambient electron densities with satellite-borne cylindrical probes exhibit periodic variations synchronous with the satellite spin cycle. Representing these fluctuations as a superposition of effects attributable to both the presence of the satellite wake and the geomagnetic field leads to a model of the modulations of accelerated electron current to cylindrical probes in which one modulation component displays current variations dependent on the probe velocity angle (ψ), and the other displays variations dependent on the angle between the probe axis and the geomagnetic-field lines (β). The modulations produce an electron current decrease whenever the probe axis rotates into the satellite wake or whenever the probe axis rotates toward alignment with the geomagnetic-field lines. As altitude increases, the modulation dependent on ψ decreases, whereas the modulation dependent on β increases. The ψ-dependent modulation component can be associated with the presence of a wake structure, and the β-dependent component can be associated with the magnetic influence on the transport properties of thermal electrons, assuming the electron fluxes are predominately along the field lines. The analysis results imply that the most accurate determinations of atmospheric electron densities by satellite-borne cylindrical probes come from measurements taken out of the wake of the satellite when the probe axis is within 20° of being perpendicular to the geomagnetic-field lines. (auth)

39402 ANALYTIC APPROACH TO PHOTOELECTRON TRANSPORT. Stolarski, R. S. (Univ. of Michigan, Ann Arbor). J. Geophys. Res.; 77: No. 16, 2862-70(1 Jun 1972).

The equation governing the transport of photoelectrons in the ionosphere is shown to be equivalent to the equation of radiative transfer. In the single-energy approximation this equation is solved in closed form by the method of discrete ordinates for isotropic scattering and for a single-constituent atmosphere. The results include prediction of the angular distribution of photoelectrons at all altitudes and, in particular, the angular distribution of the escape flux. The implications of these solutions in real atmosphere calculations are discussed. (auth)

39403 LONGITUDINAL VARIATIONS OF THERMOSPHERIC COMPOSITION INDICATING MAGNETIC CONTROL OF POLAR HEAT INPUT. Hedin, A. E.; Reber, C. A. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 16, 2871-9(1 Jun 1972).

Measurements of neutral N_2, O, and He densities from Ogo 6 over the south polar region during magnetically quiet periods in late August and early September 1969 indicate that N_2 densities, when they are extrapolated to a common altitude, maximize at about 0800 UT near 70° invariant latitude. The density of He has a minimum at this time, and the density of O has a slight maximum. It is proposed that these phenomena are the result of cyclic variations in soft electron precipitation, which heats the thermosphere either directly or through enhanced Joule heating. This heat energy would increase the gas temperature, the increase in the gas temperature leading to the N_2 increase, and would vary the composition by generation of a wind system. (auth)

39404 POSITIVE-ION COMPOSITION MEASUREMENT IN THE UPPER MESOSPHERE AND LOWER THERMOSPHERE AT A HIGH LATITUDE DURING SUMMER. Johannessen, A.; Krankowsky, D. (Max,Planck-Institut fuer Kernphysik, Heidelberg). J. Geophys. Res.; 77: No. 16, 2888-2901(1 Jun 1972).

A composite sounding rocket payload was launched from Andoya Rocket Range (69°17′N) on August 8, 1971, 12.11 GMT; it reached a peak altitude of 99.1 km. The main purpose of the launch was to study the ion composition around the cold summer mesopause and its relation to ambient temperature, production, and loss rates. Ions were detected by the mass spectrometer from a height of 70.7 km on the ascent to a height of 69.8 km on the descent, water-cluster ions $H^+(H_2O)_n$ dominating the composition below 84 km. Cluster ions of a higher order of hydration appeared with increasing height until a rapid cutoff occurred in the region from 84.5 to 86.0 km. Simultaneously, metal ions Mg^+ and Fe^+ appeared, and NO^+ and O_2^+ emerged as dominating species. The largest cluster ion found during ascent was (109 ± 1) amu, probably $H^+(H_2O)_6$, detected in one spectrum at 84.5 km. During descent the largest cluster detected was (91 ± 1) amu, probably $H^+(H_2O)_5$, found in three spectra between 85.9 and 82.2 km. In the cluster-ion region the concentration of O_2^+ exceeded that of NO^+, whereas NO^+ exceeded O_2^+ above the region, the crossover taking place near the water-cluster cutoff. (auth)

39405 LUNAR SEMIDIURNAL VARIATION IN O I(5577 A) NIGHTGLOW. Forbes, J. M.; Geller, M. A. (Univ. of Illinois, Urbana). J. Geophys. Res.; 77: No. 16, 2942-7(1 Jun 1972).

The effect of lunar tidal dynamics on the O I(5577 A) airglow is studied for Chapman's (1931) reaction, Barth's (1964) mechanism, and the F-region contribution to the green-line intensity. The computed E-region variations are of the same order as the observed lunar variations in the airglow and agree well in phase. The F-region contribution is found to be of roughly the same order as the lunar variation that is calculated for the E region but to have possibly a much different phase. It is concluded that the dynamics of the lunar tide are sufficient to produce a lunar variation in green-line airglow that is similar to the observed variation. (auth)

39406 AURORAS AND ASSOCIATED PHENOMENA. Feldshtein, Ya. I. (IZMIRAN, Moscow). Astrophys. Space Sci. Libr.; 29: Pt. III, 152-91(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The dynamics of the auroral oval and its dependence on DP intensity are examined. Even during extremely magneto-quiet periods, auroras are observed and located along a contracted oval. In the noon sector, auroras occur at $\varphi \approx 80°$, in the midnight sector at $\varphi \approx 70°$. This is in agreement with observations made from satellites and aircraft. It is shown that in the night sector the equatorward boundary of the auroral oval coincides with the projection on the polar ionosphere, along field lines, of the inner boundary of the plasma sheet in the tail. In the day sector, the equatorward boundary of the auroral oval coincides with the "feet" of the outermost closed field lines. Thus, the equatorward boundary of the oval coincides with the boundary between the quasi-dipole field lines and the stretched field lines. This relationship is then used to infer the geocentric distance of the subsolar point of the magnetopause and also the relationship between variations of the solar wind pressure and of DP intensity. Akasofu's pattern of the development of the auroral substorm is extended to include a new phase, called the "creation phase", which is characterized by an equatorward motion of auroras in the oval in the midnight sector. The velocity of some auroral forms during different phases of the auroral substorm is used to determine the direction and intensity of electric fields in the magnetosphere. The amount of energy released in auroras during substorms is estimated, and its dependence on DP intensity is given. (166 references) (auth)

39407 INTERPRETATION OF IONOSPHERIC EFFECTS OF SOLAR FLARES. Mitra, A. P. (National Physical Lab., New Delhi). Astrophys. Space Sci. Libr.; 29: Pt. IV, 1-26(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Ionospheric effects due to solar flares have been studied from methods including sudden absorption increases observed with hf commercial CW transmissions (SWF) or with riometers (SCNAs), and with pulse absorption techniques; vlf/lf phase and amplitude changes (SPA, SEA, SES); and sudden frequency deviations observed with hf standard frequency transmission (SFD). These indirect effects arise because of an enhancement in ionization that progressively decreases with height from a factor of 5 to 10 around 70 to 80 km to about 50 to 100% in the E region and about 1 to 20% in the F region. To study the flare-associated ionospheric effects, it is desirable to have the complete time history and the spectral distribution of the ionizing flux, along with changes in the spectra distribution; the nature and concentrations of the atmospheric constituents ionized; and the nature of the effective loss rate. These data are not known for any one event. (48 references) (J.C.W.)

39408 BEHAVIOR OF IONIZED COMPONENTS IN THE CHEMISTRY AND AERONOMY OF D AND E REGIONS. Danilov, A. D. (Hydrometeorological Service, Moscow). Astrophys. Space Sci. Libr.; 29: Pt. IV, 27-40(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The main problem of the ionospheric E region is the night source of ionization. Several sources are discussed: scattered $L\alpha$ and $L\beta$ emission, corpuscular fluxes. The latter were recorded in a number of rocket experiments, and their energy is enough for explanation of observed rate of recombination during the night. The behavior of ion-concentrations ratio NO^+/O_2^+ with height and time is connected with additional processes of transformation of O_2^+ ions to NO through ion-molecular reactions. The main problems of the D-region physics are: whether, or not are true measured high concentrations of positive ions and nitric oxide. Estimates, based on measured values of [e] and α' give low values of λ in contradiction with probe measurements. The modern scheme of negative-ion transformations can explain some experimental data if an additional source of conversion O_3^- ions to NO_2^- is suggested. (70 references) (auth)

39409 CHEMISTRY OF NEUTRAL SPECIES IN THE D AND E REGIONS. Bowhill, S. A. (Univ. of Illinois, Urbana). Astrophys. Space Sci. Libr.; 29: Pt. IV, 41-52(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The photodissociation of molecular species such as oxygen, nitrogen, and water vapor in the upper atmosphere leads to the formation of a reservoir of chemical energy consisting of highly reactive atomic gases. The reactions of these with each other, and with the rest of the atmosphere, give a complex neutral chemistry involving many species and reactions. Local equilibrium can rarely be assumed for these reactions; transport by the horizontal and vertical mean flow, by eddy diffusion, and by molecular diffusion has quite different effects on the various constituents, depending on the time constants. The entire subject of the neutral chemistry in the D and E regions (between 50 and 160 km altitude) is reviewed, and related to existing experimental results. (auth)

39410 TRANSPORT PROCESSES IN THE THERMOSPHERE. Johnson, Francis S. (Univ. of Texas, Dallas. Southern Methodist Univ., Dallas). Astrophys. Space Sci. Libr.; 29: Pt. IV, 53-67 (1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The atmosphere is highly stratified, even to high levels, and hence important transport questions arise in which vertical transport alone constitutes a useful approximation. Thus, the thermosphere was first described in terms of molecular conduction transferring heat from higher levels to lower, which is required because of the lack of adequate energy emission mechanisms at the higher levels. Later, the importance of eddy conduction was recognized as a means of extending the treatment well down into the mesosphere, where finally radiative processes are powerful enough to dispose of the excess heat deposited at the higher levels. Transport problems also arise with regard to atmospheric constituents, and several studies have been made of this problem. These considerations have provided a conceptually complete description of the upper atmosphere in the approximation that horizontal transport can be neglected. Two different approaches have been undertaken to consider the horizontal transport by large-scale circulation. First and most direct, the horizontal wind field in the middle and upper thermosphere was calculated based on the pressure distributions derived from satellite orbital decay observations. Then continuity conditions were used to calculate the vertical motions. The second approach was to evaluate the energy deficits or surpluses as a function of altitude and latitude and to assume the presence of vertical motions sufficient to balance these deficits or surpluses by compressional heating or cooling. Then continuity conditions were used to derive horizontal winds. The results of the two approaches are compatible, and are largely complementary. Downward velocities are near 1 m s^{-1} at 300 km over the diurnal minimum and the winter polar region, and 1 cm s^{-1} at 100 km over the winter polar region. (auth)

39411 EXOSPHERE AND GEOCORONA. Mange, P. (Naval Research Lab., Washington, D. C.). Astrophys. Space Sci. Libr.; 29: Pt. IV, 68-86(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The observational evidence was reviewed on the hydrogen geocorona including its density, vertical structure, and the nature of its diurnal and other solar-related variability. The relationship of observationally derived models of the exosphere and geocorona to the thermosphere is indicated. The hydrodynamic and kinetic descriptions of the origin of the polar wind, the outward supersonic ion flow over the poles, are briefly reviewed. Observations of vertical ion distributions, of the supersonic flow of ionized atomic hydrogen, and of the polar depletion of atomic hydrogen are cited as evidence for the polar wind. These results are interpreted as clues to the geographical extent of the polar wind and its correlation with the plasmapause. (44 references) (auth)

39412 ELECTRIC FIELDS AND THEIR EFFECTS IN THE IONOSPHERE: SUMMARY OF OBSERVATIONS. Haerendel, G. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Astrophys. Space Sci. Libr.; 29: Pt. IV, 87-116(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The quasi-static electric field is a fundamental parameter of the physical processes in the magnetosphere and ionosphere. Yet it is difficult to measure. Previous data relied on indirect evidence, mostly derived through relating the magnetic perturbations on the ground to an overhead ionospheric current (Maeda, 1955; Axford and Hines, 1961). During the last few years a number of different techniques have been developed and successfully applied that provide a quickly growing body of data on the electric field or the plasma convection (Völk and Haerendel, 1970). All these techniques are of limited applicability. Simultaneous observations using two or more different methods are highly desirable for experimental cross checks and for obtaining complementary information. A few conclusions from these data on the electromagnetic coupling of the ionosphere and magnetosphere and on the magnetospheric convection are given. (101 references) (auth)

39413 ELECTRIC FIELDS AND THEIR EFFECTS IN THE IONOSPHERE: A THEORETICAL TREATMENT. Bramley, E. N. (Radio and Space Research Station, Ditton Park, Eng.); Pudovkin, M. I. Astrophys. Space Sci. Libr.; 29: Pt. IV, 117-41(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The sources and magnitudes of electric fields that occur in the ionosphere were briefly described. The relationship between electric fields and currents, and the problems of deducing current systems from magnetic data, were discussed; in particular the DP-current system and its associated electric fields were considered in detail. The effects of electric fields on ionization distributions are described under three headings, namely large-scale distributions, effects on irregular structures, and the production of irregularities. (112 references) (auth)

39414 INTERACTION BETWEEN THE MAGNETOSPHERE AND THE IONOSPHERE. Hultqvist, B. (Kiruna Geophysical Observatory, Sweden). Astrophys. Space Sci. Libr.; 29: Pt. IV, 176-98(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Relations between certain structures in the magnetosphere and the ionosphere are discussed in the light of experimental evidence as well as from the point of view of the physical mechanisms thought to cause the structures. New evidence for the fairly frequent occurrence of magnetic-field-aligned electric fields is described. The interpretation of these data in terms of an electrostatic field in or near the upper ionosphere, associated with the temperature difference between the magnetospheric and ionospheric plasmas, is discussed in some detail. (100 references) (auth)

39415 THEORETICAL MODEL OF F-REGION STORMS. Obayashi, Tatsuzo (Tokyo Univ.); Matuura, Nobuo. Astrophys. Space Sci. Libr.; 29: Pt. IV, 199-211(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Large-scale F-region disturbances, which are manifested by changes in the global electron-density profile, are known to be accompanied by magnetic storms. The electron density in the F region is generally enhanced in low latitudes, while it is depressed in middle and high latitudes. Several mechanisms are considered to contribute to the electron-density change, and it is shown that the abundance ratio of atomic oxygen to molecular oxygen or nitrogen is a dominant parameter to control the electron-density change. A theoretical model of F-region storms, which is compatible with the observed features, is proposed. (44 references) (auth)

39416 STUDIES OF E-REGION IONOSPHERIC MOVEMENTS FROM MEASUREMENTS OF THE GROUND DIFFRACTION PATTERN PRODUCED BY 300-kHz RADIO WAVE REFLECTIONS. Bulman, George Roderick Peter. University Park, Pa.; Pennsylvania State Univ. (1971). 128p. University Microfilms Order No. 72-13,823.

Thesis.

An automatic recording system for making amplitude and phase measurements of the ground diffraction pattern produced by the ionospheric reflection of a 300-kHz pulsed radio signal at vertical incidence is described. Representative amplitude and phase records and complex correlation functions obtained from six nighttime test runs, each lasting about forty minutes, are included. Peaks in the magnitude of the complex power spectra showed dominant Doppler frequency components present during five of the six runs. Due to inherent experimental limitations it was not possible to determine whether these Doppler frequencies resulted from wave motions or from individual moving irregularities in the ionosphere. Drift velocity and structure size calculations that result from the full correlation of amplitude measurements alone are only valid if the reflection process consists of a large number of random events. The presence of dominant Doppler components in the diffraction pattern can be detected from the complex power spectrum analysis of the complex amplitude measurements of the diffraction pattern, but it is difficult to detect these components from amplitude measurements alone. It is concluded that the lower E region cannot be represented by a wholly statistical model and that velocity and structure size calculations that are made using amplitude measurements alone in the classical manner are subject to considerable errors and must be treated with caution. (TSS) (Diss. Abstr. Int., B)

Particle Kinetics and Trapping

Refer also to abstract 39414.

39417 GEOMAGNETIC FIELD DISTORTIONS AND THEIR EFFECTS ON RADIATION-BELT PARTICLES. Roederer, Juan G. (Univ. of Denver). Rev. Geophys. Space Phys.; 10: No. 2, 599-630(May 1972).

The study of trapped-particle motion in the Earth's magnetic field is usually geared toward building the foundation of radiation-belt dynamics (particle injection, acceleration, diffusion, and loss). Trapped-particle motion is used here to explore the properties of the geomagnetic field itself. One of the quadrupole terms in the main geomagnetic field is found to contribute to a north—south "shear distortion" of the particle-drift shells, whereas one of the octupole components causes a longitude-dependent radial deformation and associated drift-shell splitting. The collective action of all higher multipoles on trapped-particle motion is then used to analyze the "true" anomalies or distortions of the internal geomagnetic field that are independent of the quadrupole-related eccentricity of the main dipole. These true anomalies must originate in upper-mantle or crustal perturbations that lie relatively near the Earth's surface on both sides of the mid-Atlantic ridge; they influence trapped-particle drift shells only where the latter have their closest approach to the Earth (South Atlantic and South African areas). The quadrupole and octupole perturbations, on the other hand, obviously originate deep in the Earth's core. The most adequate space and particle coordinate systems are introduced, and their validity is briefly analyzed. The effects of external magnetospheric currents are discussed. A time-dependent symmetric ring current causes drift shells to be displaced radially, with associated particle acceleration; magnetopause currents introduce a day—night asymmetry, causing shell splitting. Time dependence of these effects introduces further complications; an invariant particle coordinate system is discussed that can be used for particle-flux representations that are independent of the particular instantaneous field configuration (provided that the latter is known and that all changes occur slowly, i.e., adiabatically). (44 references) (auth)

39418 MAGNETIC FLUXES IN THE MAGNETOTAIL AT VARIOUS PHASES OF A SUBSTORM. Fel'dshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Dokl. Akad. Nauk SSSR; 201: No. 1, 82-5(1 Nov 1971). (In Russian).

The structure of the geomagnetic field and plasma associated with different forms of polar aurorae, together with the changing configuration of the field, were derived both from direct measurements and from circumstantial evidence. The change in magnetic flux from one polar cap in the magnetotail was evaluated for different phases of the evolution of a substorm at various angles of inclination of the axis of the geomagnetic dipole relative to the ecliptic plane. (K.S.W.)

39419 CONSEQUENCES OF AN ISOTROPIC STATIC PLASMA SHEET IN MODELS OF THE GEOMAGNETIC TAIL. Siscoe, G. L. (McDonnell Astronautics Co., Huntington Beach, Calif.). Planet. Space Sci.; 20: No. 6, 937-53(Jun 1972).

The equation of momentum balance and magnetic flux conservation are given for a static tail model with an isotropic plasma sheet. The possibility of magnetic-field leakage into the solar wind and across the neutral sheet is allowed. Numerical integrations for a wide variety of adjustable model parameters are presented that given the dependence on distance from Earth of all tail parameters (field strength inside and outside of the plasma sheet, plasma pressure, plasma sheet area, tail radius, and normal field component to the neutral sheet). The model gives good agreement with the observed distance dependence of the tail field strength, and accounts for the scatter in the data in terms of a mixture of the fields inside and outside the plasma sheet in the data averages. However, compared with the present interpretations of the observations the model gives a too-large plasma pressure at large distances and a too small normal component to the neutral sheet. The discrepancies imply that plasma flow and/or pressure anisotropy are required for an adequate model. (auth)

39420 ELECTRON PITCH-ANGLE DIFFUSION DRIVEN BY OBLIQUE WHISTLER-MODE TURBULENCE. Lyons, L. R.; Thorne, R M.; Kennel, C. F. (Univ. of California, Los Angeles). J. Plasma Phys.; 6: No. 3, 589-606(Dec 1971).

A general description of cyclotron harmonic resonant pitch-angle scattering is presented. Quasi-linear diffusion coefficients are prescribed in terms of the wave normal distribution of plasma wave energy. Numerical computations are performed for the specific case of relativistic electrons interacting with a band of low frequency whistler-mode turbulence. A parametric treatment of the wave energy distribution permits normalized diffusion coefficients to be presented graphically solely as a function of the electron pitch-angle. The diffusion coefficients generally decrease with increasing cyclotron harmonic number. Higher harmonic diffusion is insignificant at very small electron pitch-angles, but becomes increasingly important as the pitch-angle increases. One thus expected the rate of pitch-angle scattering to decrease with increasing electron energy, since the resonant value of the latter varies proportionately with harmonic number. This indicates that, in mirror-type magnet field geometrics, such as the Earth's radiation belts, the diffusion losses of high energy electrons are likely to be appreciably slower than those at low energy. Integration of the diffusion rates along a complete bounce orbit will be required to clarify this point, however, since the high-energy particles will be subject to more rapid first harmonic diffusion near their mirror points. (auth)

39421 LUNAR SEMIDIURNAL VARIATIONS OF THE GEOMAGNETIC FIELD DETERMINED FROM THE 2.5-MIN DATA SCALINGS. Matsushita, S. (National Center for Atmospheric Research, Boulder, Colo.). J. Atmos. Terrest. Phys.; 34: No. 7, 1187-1200(Jul 1972).

Most previous investigations of the lunar variations, L, in the geomagnetic field were conducted using hourly values scaled from magnetograms and hence many years data were required to obtain reasonable results. Only recently magnetic tapes of scaled-field values for every 2.5 min become available for a number of world stations. These data allow the examination of the L variations fairly accurately even for a small number of days. The method involved the exclusion of days of high solar–terrestrial activity ($K_p > 3+$); removal of the solar quiet, Sq, variation; alignment of the data on a lunar-time scale; and, finally, computing the first four Fourier components to fit the averaged 2.5-min values. For an example of determination by this method, the month-to-month, seasonal, and solar-cycle variations of the lunar semidiurnal field components at Fredericksburg and Huancayo from 1964 through 1966 and at Honolulu from 1964 through 1968 were computed. The amplitudes and relative phases of the lunar semidiurnal component between day and nighttime at Huancayo were also obtained. A comparison with results of older methods was made whenever it was applicable. (auth)

39422 POLAR-CAP STRUCTURES OF SOLAR PROTONS OBSERVED DURING THE PASSAGE OF INTERPLANETARY DISCONTINUITIES. Scholer, M. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). J. Geophys. Res.; 77: No. 16, 2762-9(1 Jun 1972).

Particle measurements from the low-altitude polar-orbiting satellite GRS-A/Azur and from the Imp-5 satellite inside the magnetosphere near the magnetopause and particle and magnetic-field measurements in interplanetary space from the Heos-A1 satellite are presented for the solar-proton event of March 1970. Comparison of interplanetary magnetic-field and particle data indicate that a flux increase lasting 20 min is associated with an interplanetary magnetic filament. A following sharp flux increase is attributed to an interplanetary magnetic discontinuity. As the discontinuity with different proton fluxes on both sides is swept over the Earth, the particles immediately enter the magnetosphere near the neutral sheet, and the higher flux is observed without time delay in the quasi-trapping region over the polar cap. The central polar cap is still dominated by particles entering via the distant magnetospheric tail. The discontinuity is convected along the tail and ultimately reaches the region where field lines originating in the central polar cap are connected to or intermingled with the interplanetary field. Filling up of the polar cap in less than 2 hours to the higher flux level results in a maximum "tail length" of about 550 R_E. (auth)

39423 HIGH-LATITUDE LOW-ENERGY ELECTRON FLUXES AND VARIATION OF THE MAGNETOSPHERIC STRUCTURE WITH THE DIRECTION OF THE INTERPLANETARY MAGNETIC FIELD AND WITH THE GEOMAGNETIC ACTIVITY. Hruska, A.; Burrows, J. R.; McDiarmid, I. B. (National Research Council of Canada, Ottawa). J. Geophys. Res.; 77: No. 16, 2770-9(1 Jun 1972).

The variation of the high-latitude boundary of the low-energy ($E > 35$ keV) outer-zone electrons with the direction of the interplanetary magnetic field (IMF) is discussed. The particle data from the polar-orbiting satellite Alouette-2 and magnetic-field data from Explorer 33 and 35 are used. Structure of the high-latitude fluxes of electrons ($E > 35$ keV) on the nightside of the Earth is analyzed on the basis of Alouette-2 and Isis-1 particle data. Predictions about the magnetotail structure, based on these data are tested by using data from the Imp-3 magnetic-field experiment. If the IMF has a southward component, the electron boundary is displaced poleward with respect to the average position in the interval from approximately 2000 to 1000 MLT and is displaced equatorward from 1000 to about 2000 MLT. The intensity versus latitude profiles, which are displaced poleward with respect to the average boundary latitude, are characterized by structured fluxes near the high-latitude boundary seen most clearly around and/or after midnight. The probability of the occurrence of such structured profiles depends strongly on the direction of the IMF and increases with the geomagnetic activity. Dawn-dusk asymmetry in the occurrence and structure of the high-latitude electron fluxes is associated with a dawn-dusk asymmetry in the structure of the geomagnetic tail such that the magnetic field in the plasma sheet is weaker on the dawnside than on the duskside. (auth)

39424 TRAPPING BOUNDARY AND FIELD-LINE MOTION DURING GEOMAGNETIC STORMS. Kaufmann, Richard L. (Univ. of New Hampshire, Durham); Horng, Jiann-tsorng; Konradi, Andrei. J. Geophys. Res.; 77: No. 16, 2780-98(1 Jun 1972).

The high-latitude trapping boundary for 20-keV electrons and 100-keV protons became very thin in the early morning hours during two intense substorms. The gradients were too steep to be maintained by drifting particles, so they must have been produced locally over the nightside of the Earth. The flux gradient is seen to move at speeds in excess of 100 km/sec. Plasma appears to move away from the tail and around the Earth at these high speeds during the sudden expansion phases of the substorms. The rapid plasma motion requires the presence of fluctuating electric fields that sometimes exceed 50 to 100 mV/m at a geomagnetic latitude of 30° on the $L = 5$ field line. Observations fit best into a model that contains two field-aligned sheet currents. Current flows down toward the ionosphere at or beyond the poleward edge of the disturbance and away from the Earth at lower latitudes. The high-latitude trapping boundary appears to be distorted by waves. As these waves propagate around the Earth, the satellite alternately enters and leaves the trapped-particle region. Electrons that have been newly accelerated during the substorm arrive at the satellite at about the same time that ground activity commences at the satellite's local time. The high electric fields that accompany the rapid plasma flow can produce nonadiabatic acceleration of 0.1- to 1-MeV electrons and protons. (auth)

39425 GEOMAGNETICALLY TRAPPED CARBON, NITROGEN, AND OXYGEN NUCLEI. Mogro-Campero, Antonio (Univ. of Chicago). J. Geophys. Res.; 77: No. 16, 2799-2818(1 Jun 1972).

Measurements carried out with the University of Chicago nuclear composition telescope on the Ogo-5 satellite have established the presence of 13 to 33 MeV/nucleon geomagnetically trapped C and O nuclei, with some evidence for N nuclei. These trapped nuclei were found at $L \leq 5$ and near the geomagnetic equator. The data cover the period from March 3, 1968 to December 31, 1969. The distribution of CNO flux as a function of L is given. No change in the intensity of the average trapped CNO flux was detected by comparing data for 1968 and 1969. For combined 1968 and 1969 data, first, the average CNO flux at $L = 4$ is $dj/dE = (9.2 \pm 3.2) \times 10^{-4}$ particle/cm^2-ster-sec-MeV nucleon, or ~100 times the interplanetary CNO flux level in the same energy interval, and, second, the abundance ratio is $O/C = 0.5 \pm 0.4$, which is consistent only with extraterrestrial sources for these nuclei, as noted earlier. The results reported set a new value for the observed high-energy limit of trapping as described by the critical adiabaticity parameter. The penetration of solar-flare CNO up to $L = 4$ was observed twice in 1968, in disagreement with Störmer theory predictions. The effects of these results on some models for the origin of the trapped radiation are discussed. (auth)

39426 NONLINEAR THEORY OF CROSS-FIELD INSTABILITY WITH APPLICATION TO THE EQUATORIAL ELECTROJET. Rogister, Andre (European Space Research Organization, Frascati, Italy). J. Geophys. Res.; 77: No. 16, 2975-81(1 Jun 1972).

A nonlinear theory of the cross-field instability is presented in which the energy is transferred by mode coupling from large to small wavelengths, where it is absorbed by linear damping (classical diffusion). The parameters are chosen to fit the conditions prevailing in the equatorial electrojet when the instability is most easily observed. (auth)

39427 TWO SUCCESSFUL GEOMAGNETIC-FIELD-LINE TRACING EXPERIMENTS. Wescott, E. M. (Univ. of Alaska, College); Peek, H. M.; Nielsen, H. C. S.; (and others). J. Geophys. Res.; 77: No. 16, 2982-6(1 Jun 1972).

Two field-line tracing experiments were conducted on an L = 1.26 magnetic-flux tube over Kauai, Hawaii, in Oct. 1971. Barium vapor with forward velocities of up to 15 km/s was created in the detonation of a highly explosive shaped charge aligned along the geomagnetic field at 467 km. Barium ions traveled along the field line to the conjugate ionosphere in a tube 3 to 5 km in diameter, producing a visible streak along the entire 6900-km path length. Electric fields (~1 mV/m) perpendicular to the magnetic field caused the ions to drift away from the true conjugate during transit, but extrapolation from subsequent ion drift rates allows the conjugate to be identified and compared with several field models. Different ion drift rates and directions at the conjugate points indicate that the E field is not transferred unattenuated along field lines. Striations appeared in both the northern and the southern clouds at late times at lower altitudes where interaction with the neutral wind is significant. The striations extended upward along the field lines at around E + 26 min. N_2^+ emissions were observed in the southern deposition region. (J.C.W.)

39428 MAGNETOSPHERIC ELECTRIC FIELDS DEDUCED FROM DRIFTING WHISTLER PATHS. Carpenter, D. L.; Stone, Keppler; Siren, Jan C.; Crystal, T. L. (Stanford Univ., Calif.). J. Geophys. Res.; 77: No. 16, 2819-34(1 Jun 1972).

The amplitude of the E—W component E_w of the convection electric field in the nightside magnetosphere has been inferred from the observed cross-L motions of whistler ducts within the plasmasphere. Several ducts distributed over 1 to 2 R_E in L space and over ±15° around the longitude of the Eights, Antarctica, whistler station were tracked simultaneously. The method appears capable of resolving fluctuations in E_w with period $T \sim 15$ min and rms amplitude as low as 0.05 mV/m. For variations with $T > 1$ hour the method has a sensitivity of the order of 0.01 mV/m. Three case studies are presented, two of which illustrate convection activity associated with relatively isolated substorms. In these two cases E_w reversed from westward to eastward for a period following the decay of substorm bay activity. In the third case the substorm bay activity was prolonged, and E_w remained westward and at enhanced levels until local dawn. Evidence was found that, at least in a limited longitudinal sector, perturbing substorm E_w fields can penetrate deep within the plasmasphere. In two of the case studies comparisons of E_w and the interplanetary magnetic-field θ component show evidence of a possible relation based on brief (≤ 1 hour) southward excursions but not on long preceding southward events. The growth of E_w can take the form of an initial brief (<15 min) positive surge followed by a larger surge that is simultaneous with the most active phase of the substorm. Certain of the pronounced increases in E_w were found to be coincident with activation or spreading of electrojet or auroral activity. In one instance low-amplitude (<0.1 mV/m) presubstorm fluctuations in E_w with periods of the order of 30 min were found to correlate closely with ground-observed mid-latitude fluctuations in the magnetic H component. Calculated values of E-field power spectral density from the tracking of two long-lived (~6 hours) whistler paths reveal considerable fine structure. The falloff with frequency roughly as f^{-2} agrees approximately with results from balloons, but the calculated spectral amplitudes appear lower than the balloon results by a factor of ~4. The amplitudes from whistlers appear to be within the range identified by other workers as sufficient to drive radial diffusion in the radiation belts. The present research agrees with balloon measurements on the general presence of a westward field during substorms, but there is apparent disagreement on a number of details, including the post-substorm reversal in E_w. (auth)

39429 COMPUTATION OF THE LUNAR DAILY VARIATION AND ERROR ANALYSIS. Petersons, H. F. (Australian National Univ., Canberra). J. Geophys. Res.; 77: No. 16, 2948-56(1 Jun 1972).

The Chapman—Miller method is modified so as to decrease the number of terms that have to be neglected and the number of computations required for the determination of the lunar daily variation. A method for estimating confidence limits is presented. Four years (1952—1955) of hourly values of horizontal intensity at Toolangi geomagnetic observatory are analyzed with the modified method. (auth)

39430 DISCONTINUITIES AND SHOCK WAVES IN THE INTERPLANETARY MEDIUM AND THEIR INTERACTION WITH THE MAGNETOSPHERE. Burlaga, Leonard F. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Space Sci. Libr.; 29: Pt. II, 135-58(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The discontinuous structure of the solar wind is described with emphasis on properties related to geomagnetic impulses. Some of the discontinuities are clearly hydromagnetic shocks and tangential discontinuities, and can produce a significant change in the momentum flux at the magnetosphere boundary. Such a change generates an impulse that propagates through the magnetosphere to the Earth where it is observed worldwide as an impulse in magnetograms. The propagation process is not reviewed here, but the relation between the initial cause (discontinuity) and the final effect (geomagnetic impulse) is reviewed in detail. The various types of impulses are examined, and are related qualitatively to the various types of discontinuities. The magnitude of an impulse is related to the change in the momentum flux. The propagation time and the rise time depend on the propagation process rather than on the initial state. Double shocks have not been observed, but a reverse shock has been identified. Giant pairs can be caused by a shock followed by a tangential discontinuity, and regular pairs may be due to complementary tangential discontinuities. (86 references) (auth)

39431 CONFIGURATION OF THE GEOMAGNETIC FIELD. Fairfield, D. H. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Space Sci. Libr.; 29: Pt. III, 1-24(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Spherical harmonic representations of the geomagnetic field based on ground-based and low-altitude spacecraft measurements adequately describe the field within several Earth radii of the Earth's surface. As the internal field decreases with increasing distance from the Earth, external field sources become relatively more important. In the region 3 to 6 R_E magnetospheric plasma inflates the field lines and decreases the field strength by an amount that is typically 10's of gammas and occasionally 100's of gammas. At greater distances on the day side of the Earth the solar wind compresses the field and produces equatorial field strengths of approximately 60 γ at 10 R_E. Field lines near the magnetopause intersect the Earth at 78° latitude in the sunward hemisphere. The solar wind drags high latitude field lines away from the Earth in the night hemisphere forming the geomagnetic tail and neutral sheet. The average equatorial field at 10 R_E near midnight is approximately 8 γ and the best estimate for the last closed line of force near midnight in an average magnetosphere is 69°. Magnetic-tail field lines away from the neutral sheet diverge in both the east—west and north—south directions and the average quiet time magnitude decreases from 16 γ at 20 R_E to 7 γ at 80 R_E. Within 6 R_E of the equatorial plane the field strength is depressed by several gammas. Asymmetric field inflation in the magnetosphere occurs during magnetic disturbances with the largest effects concentrated in the evening quadrant. The tail configuration can deviate substantially from the average configuration during magnetic disturbances. Prior to a substorm the configuration is characterized by a maximum number of lines extending far into the tail and relatively little flux crossing the equatorial plane. After a substorm or during quiet times the tail is characterized by an increased number of field lines crossing the equatorial plane in cislunar space. (50 references) (auth)

39432 PARTICLE MOTIONS IN THE EARTH'S MAGNETOSPHERE. Shabanskii, V. P. (Moscow State Univ.). Astrophys. Space Sci. Libr.; 29: Pt. III, 25-65(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Two specific regions of the magnetosphere are considered; (1) the magnetospheric tail, the region characterized by a sharp break of magnetic-field lines at the neutral sheet (i.e., lines that close an indefinite but large distance from the Earth) and (2) the magnetospheric core, the region with smooth closed lines of force. The maximum possible rate of magnetic-field annihilation in the magnetospheric tail is estimated, using a hydrodynamic approximation and taking into account the anisotropy of the plasma pressure. This annihilation rate may be expressed in terms of an electric field that is directed from the morning side of the magnetosphere to the evening side. The motion of superthermal particles with the "one-particle approximation" is also considered. The magnetic drift shells in the magnetospheric core are calculated. In the outer distant regions of the core, the shells are split, according as the pitch angle of the particles is greater or smaller than a critical value, and form two branches, extending into the northern and southern hemisphere, respectively. The totality of the shells that intersect the boundary of the magnetospheric core constitutes the region of quasi-trapped particles.

One aspect of particle diffusion over magnetic shells (neglecting the splitting of shells) is also considered, that is, the shape of the stable distribution function for protons that is the stationary solution of the diffusion equation, without any losses. This case is actually realized beyond the intensity maximum of proton belt. Comparison with observation shows a sharp discrepancy between the observed profiles of proton intensity near the maximum of solar activity and those predicted by the generally accepted theory of diffusion. This discrepancy may be eliminated if one takes into account the effect of the gas pressure of trapped protons on particle motions over the shells (spontaneous convection), together with the effect of external forces in the form of electric fields and of azimuthally asymmetric pulses of the magnetic field (forced convection); for this, the relation of coefficients in the Fokker–Planck equation is essentially changed. The result is independent of the specific form of the diffusion coefficient. The above-mentioned problems have been considered in more detail elsewhere (Shabanskii, 1970). (64 references) (auth)

39433 SOURCES, LOSSES, AND TRANSPORT OF MAGNETOSPHERICALLY TRAPPED PARTICLES. Williams, Donald J. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Space Sci. Libr.; 29: Pt. III, 66-130(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Trapping, pseudo-trapping, and non-trapping regions within an observed magnetospheric configuration are described. Time-averaged proton and electron distributions and available data concerning the alpha-particle distribution within the trapping and pseudo-trapping regions are presented. Observational evidence leading to the identification of major sources, losses, and transport of magnetospherically trapped particles is reviewed. Conclusions are summarized and additional suggestions offered on these factors for inner and outer-zone protons and electrons. One general result of this review is that much is now known of source, loss, and transport processes although specific experiments and calculations must still be done. It is shown that the inclusion of pitch-angle diffusion processes within the magnetosphere significantly alters the concept of stable trapping and allows a consistent quiescent description of outer-zone electrons to be formulated from energies of a few tens of kilovolts to several MeV. (~200 references) (auth)

39434 MAGNETOSPHERIC SUBSTORMS: A MODEL. Akasofu, S.-I. (Univ. of Alaska, College). Astrophys. Space Sci. Libr.; 29: Pt. III, 131-51(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

An attempt is made to integrate and interpret various polar and magnetospheric substorm phenomena as consequences of the acceleration process of auroral particles that could result from the diversion of a part of the magnetotail current to the night side of the auroral oval. (77 references) (auth)

39435 MAGNETOSPHERIC PLASMA. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). Astrophys. Space Sci. Libr.; 29: Pt. III, 192-211(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Principal features of the distribution of plasma in the magnetosphere as inferred from observations of particles with energies in the keV range and below are reviewed. Low-energy electrons are found within the equatorial region of the magnetotail, where they form the plasma sheet, and throughout the outer magnetosphere, where they envelop the Earth with a complicated and as yet only partly explored structure. Within the plasma sheet, electrons typically have a number density of 0.1 to 1 cm^{-3} and a mean energy of 1 keV, while protons have the same number density and a mean energy higher by a factor of about 5; all these properties exhibit large temporal fluctuations. The sum of particle and magnetic pressures is roughly constant across the plasma sheet. The intense electron fluxes of the plasma sheet terminate at the so-called inner boundary of the plasma sheet, which is located at about 11 R$_e$ in the evening side of the magnetosphere and approaches the plasmapause near the midnight meridian. This inner boundary is characterized by a rapid decrease of electron mean energy with decreasing distance and little or no change in number density. During substorms, the inner boundary moves closer to the Earth, while deep in the magnetotail the plasma sheet first becomes thinner and then expands. Low-energy proton fluxes extend earthward as far as the plasmapause; between the inner boundary of the plasma sheet and the plasmapause, they become more intense and form the so-called ring current. Proton energy spectra show an increase of both energy and intensity with decreasing distance, while electron energy spectra show a large non-adiabatic increase of low energy fluxes at the inner boundary of the plasma sheet. Comparison between magnetotail electron densities and whistler measurements suggests that the observed plasma sheet particles may constitute the thermal particle population of the magnetotail. The plasma sheet appears to map into the auroral oval at ionospheric heights. The electron energy flux precipitated into the auroral oval is on the average $\frac{1}{4}$ of the omnidirectional electron energy flux within the plasma sheet; the decrease of the precipitated flux with increasing latitude corresponds to the decrease of the plasmà sheet flux with increasing distance from the neutral sheet. (50 references) (auth)

39436 ROLE OF THE GEOMAGNETIC TAIL IN SUBSTORMS. Dessler, A. J. (Rice Univ., Houston, Tex.). Astrophys. Space Sci. Libr.; 29: Pt. III, 212-18(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The substorm is a magnetospheric phenomenon in which a large amount of energy is suddenly given to plasma particles at various locations throughout the magnetosphere. It is now generally accepted that the energy required to drive a magnetospheric substorm is supplied by the solar wind, stored in the magnetic field of the tail between substorms, and suddenly released in the form of plasma energy during a substorm. However, there is as yet no wide agreement on the mechanism(s) that govern the behavior of the tail to produce the substorm. The understanding of this phenomenon ultimately rests on achieving a quantitative theory of the magnetic merging process in the tail, as well as a quantitative understanding of the origin of the plasma sheet in the tail. (auth)

39437 INSTABILITIES IN THE MAGNETOSPHERE: THEORETICAL TREATMENT. Dungey, J. W. (Imperial Coll. of Science and Tech., London). Astrophys. Space Sci. Libr.; 29: Pt. III, 219-35(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Classification of instabilities is discussed, but the approach adopted is a systematic development from the Vlasov equation, generalizing the concepts of Landau damping and using adiabatic approximations when these are valid. The best understood classes of instability are dominated by resonance, and for these the most important nonlinear effect is quasi-linear diffusion. Wave–wave interactions and nonresonant diffusion are not discussed. Landau damping is introduced by the case of electrostatic waves in zero field, and generalized for application to various waves in uniform, axisymmetric, and asymmetric fields, the former being further developed by Gendrin. The existence of integrals of the motion is emphasizing, and orders of magnitude estimates for mechanisms involving disturbances in different components are used to assess their relative importance. In the asymmetric case, study of a simplified model suggests that the plasma "memory" is short and that recent resonance dominates. The drift mirror instability is briefly discussed, emphasising that, while it is well known to occur in a uniform field, there must be a continous transition of the mode to one whose stability is dominated by the gradient, when the gradient is very large. Finally, Schindler's elegant treatment (Phys. Fluids, 11: 1192(1968)) of the tearing instability in neutral sheets is summarized. (auth)

39438 GYRORESONANT WAVE–PARTICLE INTERACTIONS. Gendrin, R. (CNET, Issy-Les-Moulineaux, France). Astrophys. Space Sci. Libr.; 29: Pt. III, 236-69(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Processes of gyroresonant interactions were discussed in the frame of the quasi-linear theory. Frequencies of interaction, anisotropy of the particle distribution function, and amplification and diffusion coefficients are computed for different types of interaction and different regions of the magnetosphere. Wave-packet effects are discussed. The energy and pitch-angle distributions for (p,L) interactions, (i.e. those between protons and lefthand waves) or the frequency spectrum of waves for (e,R) interactions (i.e. those between electrons and whistler mode waves) are computed for a quasi-equilibrium configuration. The conditions for the validity of the quasi-linear theory are discussed. It is shown that they are not in general fulfilled in the ulf range, so that a fully non-linear theory must be used in that case. Trapping of particles inside the waves and frequency shifts of the emission are examples of the consequences of such nonlinear effects. Applications of these theories to experimental data, which have been obtained either on the ground or with the help of satellites, are discussed: the global characteristics of Pc-1 events (frequency, occurrence, diurnal variation, and intensity) are explained; the role of the plasmapause is stressed. Generation in an inhomogeneous medium leads to specific effects in the vlf range. Some experimental evidence of the pitch-angle diffusion mechanism (ATS-satellite, rocket measurements) is also reported. (86 references) (auth)

39439 DIFFUSION AND ACCELERATION IN THE EARTH'S RADIATION BELTS. Faelthammar, Carl-Gunne (Royal Inst. of Tech., Stockholm). Astrophys. Space Sci. Libr.; 29: Pt. III, 270-96(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

A large amount of evidence shows that diffusion and acceleration are processes of basic importance in the dynamics of the geomagnetically trapped-particle population. The present review of such evidence and its interpretation is essentially limited to progress made in the period August 1966—May 1970 (defined by the STP meetings in Belgrade and Leningrad). Among the possible processes of radial diffusion, those conserving the first two adiabatic invariants have traditionally attracted most attention. The theoretical tools for evaluating diffusion coefficients are now well developed, but the insufficient observational knowledge of the disturbance fields remains an obstacle to making trustworthy predictions of the coefficients on the basis of the distribuances that cause the diffusion. The alternative of calculating diffusion coefficients from observed particle distributions is severely hampered by insufficient knowledge of the loss processes involved. A diagram is given, where various published diffusion coefficients are shown as functions of L value. Pitch-angle diffusion is covered by another review in this volume, but is mentioned briefly here, mainly in the context of its coupling with radial diffusion when L-shell splitting is present. Recent observations have shown that the magnetospheric particle population is subject to injection and acceleration events of a dramatic nature. These injection and acceleration events make the interplay between sources, losses, and radial transport less simple than envisaged in steady-state models for the maintenance of the trapped-particle population. (~140 references) (auth)

39440 ELECTRIC FIELDS IN THE MAGNETOSPHERE AND THE ORIGIN OF TRAPPED RADIATION. Tverskoyi, B. A. (Moscow State Univ.). Astrophys. Space Sci. Libr.; 29: Pt. III, 297-317(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

According to experimental data there are essential differences in the dynamics of trapped particles with magnetic drift periods more than and less than ≈1 h. The behavior of the particles with fast drift (radiation-belt particles) can be well described by the theory of diffusion resulting from sudden impulses. The considerably faster rate of transport of lower-energy particles implies the existence of low-frequency electric fields of large amplitude, the influence of which on energetic particles is reversible. The low-frequency fields are one of many interconnected effects, including particle variations, induction of ionospheric current systems, development of active forms of auroras, formation of D_{st}, etc. A probable cause of these events is the appearance and evolution of a plasma ring asymmetric in longitude in the trapped-radiation region. The asymmetry may be brought about both by particle injection into the magnetosphere and by penetration of an external electric field into the trapped-radiation region. On the assumption that the ionosphere is connected with the magnetosphere by currents along the lines of force, ensuring quasineutrality, and that an electric potential develops when these currents close in the E layer, it is possible to show that the electric fields and current systems DP-1 and DP-2 are the lowest modes of the system of eigenfunctions of the problem of relaxation of an asymmetric plasma cloud. (35 references) (auth)

39441 STRUCTURE OF THE PLASMASPHERE ON THE BASIS OF DIRECT MEASUREMENTS. Gringauz, K. I. (Radiotechnical Inst., Moscow). Astrophys. Space Sci. Libr.; 29: Pt. IV, 142-64(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The plasmasphere is the outermost region of the ionosphere that extends up to several Earth radii. It is filled with a collisionless cold plasma in which the geomagnetic field is frozen. The data obtained from the first measurements in this region (up to 1963) are given as a background. The information from experiments carried out after 1963 by means of charged-particle traps, ion mass spectrometers, and Langmuir probes installed on satellites of the Electron, IMP, and OGO series is reviewed. It comprises the space distribution of ion and electron densities, their dependence on geomagnetic activity and local time, ion composition of the plasmasphere, and charged-particle temperature. The possibility of detection of the plasmapause by the observation of more energetic charged particles is mentioned, and the results of in situ measurements are briefly compared with whistler results. The importance of plasmasphere study for the geophysics is outlined. (65 references) (auth)

39442 STRUCTURE OF THE PLASMASPHERE ON THE BASIS OF INDIRECT MEASUREMENTS. Helliwell, R. A. (Stanford Electronics Labs., Calif.). Astrophys. Space Sci. Libr.; 29: Pt. IV, 165-75(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Using whistler data the large-scale structure of the plasmasphere has been mapped in the equatorial plane. With the aid of topside-sounding data the distribution along field lines was found to have a diffusive equilibrium form. The outer boundary of the plasmasphere called the plasmapause, reaches its maximum distance from the Earth in the early evening hours and the radial profile shows variations apparently connected with convective motions. Sometimes a well-defined peak in electron density appears near L = 4, as a result of convective motion. The properties of small-scale field-aligned irregularities, or ducts, extending between the hemispheres have been measured using topside sounders and whistlers. Latitudinal thicknesses (at low altitude) of these ducts extend from less than a kilometer to tens of kilometers, with spacings up to ten times their thickness. Density variations are 1 to 10%. From drift motion of whistler ducts, east-west electric fields of magnitude 0.1 to 1.0 mV/m at L = 4 are deduced. During a substorm, plasma is somehow removed from the outer part of the plasmasphere leaving a void called the "trough." Replenishment of the trough ionization has been measured using whistlers, and occurs by upward flow from the ionosphere. The time required is in excess of eight days and hence the plasmasphere is seldom in equilibrium with the ionosphere. The downward flux from the plasmasphere at night, measured by whistlers, is sufficient to account for the nighttime F layer. (26 references) (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 39271, 39367, 39379, 39673, 40025, and 40085.

39443 BACKSCATTER OF SOLAR RESONANCE RADIATION. I. Johnson, H. E. (Univ. of California, San Diego, La Jolla). Planet. Space Sci.; 20: No. 6, 829-40(Jun 1972).

A simple model that essentially neglects temperature effects, but which includes gravity, radiation pressure, photoionization, and charge exchange, is used to calculate the angular dependence of the intensity of solar Lyman α resonantly scattered from neutral interstellar hydrogen that has penetrated the solar system; the results are then compared with the observations. The resonant scattering of He I λ584 is also treated. (auth)

39444 SOLAR WIND H AND He^+ CONTENT. Gregory, C. T. (Univ. of California, San Diego, La Jolla). Planet. Space Sci.; 20: No. 6, 841-7(Jun 1972).

Charge exchange collisions between interplanetary neutral H atoms and solar wind protons may lead to fluxes of neutral H atoms and He^+ ions in the solar wind. Photoionization of interplanetary helium atoms may also contribute to the He^+ flux. The expected fluxes of He^+ ions and neutral H atoms in the solar wind are computed. A simple model is used to compute the intensity of resonantly backscattered solar He II (λ304 Å) and Lyman α radiation. (auth)

39445 HIGHER BRANCHES OF THE DISPERSION RELATION FOR PERPENDICULAR MAGNETOSONIC WAVES IN RELATIVISTIC ANISOTROPIC PLASMAS. Cuperman, S.; Metzler, N. (Tel-Aviv Univ., Israel). J. Plasma Phys.; 6: No. 3, 541-5 (Dec 1971).

Dispersion relations are calculated and solved for frequencies near the first two harmonics of perpendicular magnetosonic waves in relativistic anisotropic plasmas. Wavelengths larger than the ion Larmor radius and large plasma frequency are assumed. It is found that, even for $T_{\parallel} \gg T_{\perp}$, the plasma is stable. This result has application to the steady-state, spherically symmetrical, expanding, solar-wind plasma. (auth)

39446 METHOD OF CHARACTERISTICS FOR SUPERSONIC FLOW OF A GUIDING CENTRE PLASMA. Whang, Y. C. (Catholic Univ. of America, Washington, D. C.). J. Plasma Phys.; 7: No. 1, 87-98(Feb 1972).

A study of the compressive magneto-acoustic waves in a guiding-centre plasma shows that the wavefront that emerges from a point disturbance after a finite time is a simple oblate spheroid with the axis of revolution parallel to the field lines. Thus, in a steady three-dimensional supersonic flow of guiding-centre plasma, a simple analytic expression can be obtained to represent the characteristic surfaces. From a proper linear combination of the governing macroscopic equations, the characteristic equation is obtained. It represents the propagation of disturbances on the characteristic surface. The characteristic theory can be used to study the interaction of the solar wind with the moon and possibly with other planetary bodies. (auth)

39447 ROTATIONAL DISCONTINUITIES IN THE SOLAR WIND. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 11: No. 5, 654-8(1971).

Translated from Geomagn. Aeron.; 11: No. 5, 765-70(1971).

A very simple closed system of hydrodynamic equations for a rarefied plasma is used to investigate the conditions on rotational discontinuities in a plasma with anisotropic pressure. It is found that jumplike changes in the magnitude of the magnetic field H are possible on anisotropic rotational discontinuities in contrast to isotropic ones and that the tangential components of H are always collinear at the front. By an analysis of simultaneously obtained plasma and magnetic data it is demonstrated that 10 out of the 11 "large velocity discontinuities" observed on Explorer 34 in 1967 can be classified as discontinuities of the rotational rather than tangential type since condition $H \{v_t\} = \{H_t\} v_n$, which in specific for rotational discontinuities and associates the jumps of the tangential solar-wind flow components with the interplanetary magnetic field, is satisfied for them. (auth)

39448 SYNTHESIS OF DATA OBTAINED AT JICAMARCA, PERU, DURING THE SEPTEMBER 11, 1969, ECLIPSE. Sterling, D. L. (Univ. of Texas, Dallas); Hanson, W. B.; Woodman, Ronald F. Radio Sci.; 7: No. 2, 279-89(Feb 1972).

Continuous measurements of electron temperatures, electron concentrations, and vertical plasma drift were made at Jicamarca during the September 11, 1969, solar eclipse. Control measurements were made on September 13, 1969. Synthesis of the observed electron concentrations was made, using a model that solved the time-dependent electron–ion continuity equations. Ions O^+, NO^+, O_2^+, and N_2^+ were treated. Physical and chemical processes pertinent to the F region were considered in a realistic way. At noon, 300 km above Jicamarca, the values $q = 290\ cm^{-3}\ sec^{-1}$ for the O^+ production rate, $\beta = 1.94 \times 10^{-4}\ sec^{-1}$ for the loss coefficient, and $H = 59$ km for the atomic oxygen scale height were obtained. All large-scale features observed in the F2 region were synthesized by the model. This synthesis was not sensitive to a simultaneous 30% reduction of q and β. (auth)

39449 TWENTY-SEVEN-DAY RECURRENCES IN THE SOLAR-WIND SPEED: MARINER 2. Gosling, J. T. (National Center for Atmospheric Research, Boulder, Colo.); Pizzo, V.; Neugebauer, M.; Snyder, C. W. J. Geophys. Res.; 77: No. 16, 2744-51(1 Jun 1972).

An autocorrelation analysis was performed on the Mariner-2 data of solar-wind speed obtained in late 1962. A statistically significant correlation associated with the solar rotation has been found near a lag of 27 days; however, the amplitude of the correlation is only about 0.4, in essential agreement with measurements of Vela 2 and 3 during the period from July 1964 to July 1967. The relatively modest correlation is interpreted to mean that a number of speed structures observed by Mariner 2 did not endure for more than one solar rotation; those structures that did endure significantly in shape, amplitude, and solar longitude from one solar rotation to the next. The analysis also shows that typical solar-wind structures occupied about 30 to 45° in solar longitude near 1 AU. (auth)

39450 LYMAN-ALPHA MEASUREMENTS OF NEUTRAL HYDROGEN IN THE OUTER GEOCORONA AND IN INTERPLANETARY SPACE. Thomas, G. E.; Bohlin, R. C. (Univ. of Colorado, Boulder). J. Geophys. Res.; 77: No. 16, 2752-61(1 Jun 1972).

Hydrogen Lyman-α (1216 A) measurements were made on a continuous basis by a two-channel photometer on Ogo 5 from March 1968 to June 1971. The highly elliptical orbit provided measurements of both the outer geocorona and of the 1216-A sky-background emission, since geocoronal scattering is minimal at the apogee distance of 150,000 km. Selected data (through 1970) are presented and an interpretation is given of the three principal discoveries to date, namely: (1) a pronounced antisolar enhancement of the geocoronal scattering beyond 70,000 km, which is believed to be evidence for a hydrogen geotail produced by solar Lyman-alpha radiation pressure; (2) a clear correlation of periodic variations in the sky background emission with solar activity associated with solar rotation; and (3) an annual variation of the 1216-A sky background emission, caused by the Earth's orbital motion within the cavity created by the solar wind in the nearby interstellar hydrogen. (auth)

39451 INFLUENCE OF THERMAL ANISOTROPY ON BEST-FIT ESTIMATES OF SHOCK NORMALS. Lepping, R. P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 16, 2957-63(1 Jun 1972).

The influence of thermal anisotropy on least-squares estimates of interplanetary shock parameters and the associated normals were studied by using the Rankine–Hugoniot equations, and a practical theorem for quantitatively correcting for anisotropic effects by weighing the before-and-after magnetic fields by the same "anisotropy parameter" h are presented. The quantity h depends only on the thermal anisotropies before and after the shock and on the angles between the magnetic fields and the shock normal. It is shown that, for fast shocks and for a liberal range of realistic conditions, the quantity h lies in the range $0.90 < h < 1.22$. The theorem can also be applied to most slow shocks, but in those instances h usually should be lower and sometimes markedly lower than unity. The previously studied fast shock of January 26, 1968, from plasma and magnetic-field measurements made on Explorer 33 and 35, is reexamined in light of this field-weighing theorem. Even for the extreme values of h given above, little change results in the shock parameters or in the shock normal, which over the full range of h is estimated to deflect by only 1.7° for Explorer 33 and 2.0° for Explorer 35. In no instance of the recalculated normal did it deflect more than 1.5° from the $h = 1$ normal for either spacecraft. These deflections are well within the (95% certainty) error cone angle, which was 7.6° for this situation. (auth)

39452 INTERPLANETARY MAGNETIC-FIELD VARIATIONS AND SUBSTORM ACTIVITY. Tsurutani, B. T. (Univ. of California, Berkeley); Meng, C.-I. J. Geophys. Res.; 77: No. 16, 2964-70(1 Jun 1972).

A fine time-scale study of interplanetary magnetic-field (IMF) variations and auroral-zone magnetograms during active (11 days of September, 1966, when auroral-zone balloon x rays were available) and moderately active (October,1965) days show that the time delay between the southward turning of the IMF and the first sign of a negative magnetic bay is typically less than 15 min. During the moderately active period 88% of all substorms ($>150\ \gamma$ auroral-zone negative magnetic bays) were associated with southward interplanetary magnetic fields. Conversely, 80% of all large southward IMF events ($B_\theta \leq -35°$, $t \geq 45$ min) were associated with auroral-zone negative bays; during some events, however, magnetic bays could not be found, even by using high-latitude stations. It is concluded that the main mechanism for the triggering of magnetospheric substorms is the southward turning of the IMF, the consequential release of stored magnetospheric and/or magnetotail energy into the auroral zones occurring typically within 15 min after the turning of the IMF. (auth)

39453 THERMAL PROPERTIES OF THE SOLAR WIND. Amata, E.; Formisano, V. (CNR, Rome). Lett. Nuovo Cim.; 4: No. 1, 23-6(6 May 1972).

Data obtained by the ESRO satellite Heos-1 for the energy distribution of the positive component of the solar wind were used for studying some features of the solar wind thermal properties. The relation between proton temperature and bulk velocity was studied. Diagrams of typical data are given. (M.O.W.)

39454 COMPOSITION AND DYNAMICS OF THE SOLAR-WIND PLASMA. Hundhausen, A. J. (Los Alamos Scientific Lab., N. Mex.). Astrophys. Space Sci. Libr.; 29: Pt. II, 1-31 (1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Recent observations pertaining to the chemical composition and dynamical behavior of the solar-wind plasma are interpreted. The solar-wind helium content has been determined in several independent series of observations; the long-term average abundance of helium relative to hydrogen is close to 4.5% by number. This ratio is lower than that usually given for the solar photosphere, possibly implying a separation of ions with different charge-to-mass ratios in the coronal expansion. Such a separation could result from gravitational settling of heavy coronal ions. A helium-rich plasma has been frequently observed some hours after the passage of a flare-associated interplanetary shock wave; this plasma has been tentatively identified as material ejected from the chromosphere or low corona by the flare. The isotope ^3He has been observed by two independent techniques and found to be $\sim 10^3$ times less abundant than ^4He. Several ions of ^{16}O have also been identified in the solar wind, with varying total abundance. The observed ionization state of oxygen can be related to the coronal temperature. Recent observations have established the ranges and average values of the fluid parameters used to describe the solar wind. Attempts to explain observed solar-wind temperatures within the framework of fluid models of the coronal expansion require hypotheses of dynamic processes that deposit or redistribute energy in interplanetary space. Some of the conflicting ideas regarding these processes are discussed. The transient behavior of the solar wind has attracted increasing observational and theoretical attention. Numerous observations of interplanetary shock waves indicate that the typical shock wave propagates at ~500 km $\sec^{-1}$ at 1 AU. In addition to this extreme class of transient phenomena, other long-term patterns of spatial or temporal variation have been found. The common occurrence of such patterns raises questions as to the applicability of the usual spherically symmetric, steady-state models of the coronal expansion in the interpretation of many solar-wind observations. (96 references) (auth)

39455 GALACTIC COSMIC-RAY MODULATION BY THE INTERPLANETARY MEDIUM (INCLUDING THE PROBLEM OF THE OUTER BOUNDARY). Dorman, L. I. (IZMIRAN, Moscow). Astrophys. Space Sci. Libr.; 29: Pt. II, 67-91(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

The present status of the galactic cosmic-ray modulation effects was reviewed, such as 11-yr variations, radial gradients, yearly variations, transverse gradients, 27-day variations, sporadic variations, Forbush decreases, cosmic-ray intensity increases before a Forbush decrease, solar anisotropy of the galactic cosmic rays and its time variations, microvariations, etc. Theoretical concepts that attempt to explain the main features of the observed events are discussed. Information about the properties of the solar wind, its magnetic field, and propagation of disturbances derived from the data on the cosmic-ray modulation effects are discussed. The 11-yr variations and their connection with various solar-activity indices, in particular with the HL index that takes account of the distribution of solar activity in heliocentric latitude, are discussed very thoroughly. The properties of the solar wind at the boundary with the interstellar medium are estimated. The turbulent transition zone of the subsonic solar wind and its possible effect on the galactic cosmic rays are studied. (80 references) (auth)

39456 ENERGETIC SOLAR PARTICLES IN THE INTERPLANETARY MEDIUM. Axford, W. I. (Univ. of California, San Diego, La Jolla). Astrophys. Space Sci. Libr.; 29: Pt. II, 110-34(1972).

From International symposium on solar-terrestrial physics; Leningrad, USSR (12 May 1970).

Models that describe the diffusion of energetic solar particles in the interplanetary medium are reviewed. Most attention is paid to the case of impulsive emission from solar flares, taking into account the effects of the interplanetary magnetic field, diffusion near the Sun, convection, and energy losses associated with the expansion of the solar wind. The case of continuous emission is also considered briefly. (73 references) (auth)

PHYSICS (ATOMIC AND MOLECULAR)

39457 PRINCIPLES OF ATOMIC AND NUCLEAR PHYSICS. Smith, C. J.; Stokes, A. R. London; Edward Arnold (1972). 554p. Pounds 7.50.

The subject is dealt with in sections: gaseous ions (the general concepts of ionization and the conduction of electricity through gases), electric discharge in gases at low pressures, the deflexions of moving charged particles in electric and magnetic fields, the charge and specific charge of an electron, positive rays and mass spectrographs and stable isotopes, the classical quantum theory, the emission of negative electrons from surfaces, relativity physics, the wave nature of particles, x-rays and their properties, crystal structure, natural radioactivity, alpha particles, beta particles, gamma radiation, the positron, the meson and other elementary particles, particle accelerating machines, the nuclear atom, neutron physics, and nuclear fission, fusion, and reactors. (UK)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 38467, 39063, 39090, 40115, and 40139.

39458 (ORO–3027-21) EXCITATION AND IONIZATION OF IONS BY ELECTRON IMPACT. Technical Progress Report, September 1, 1971–May 31, 1972. Hooper, J. W.; Feeney, R. K.; Sayle, W. E.; McPherson, D.; Schulthess, P. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-3027. 18p. Dep. NTIS.

Work done on studies of energy losses of Li particles in aluminum and carbon films and the application of previously developed facilities and techniques to the determination of electron collision data from magnetoplasma transient response studies is summarized. Results have been or will be published elsewhere. An attempt to prepare a thermionic source of Tl^+ ions by painting a methanol slurry of Tl_2CO_3, Al_2O_3, and SiO_2 on a Pt gauze and heating to the reaction temperature is described briefly. Preliminary studies indicate that a practicable thermionic emitter can be produced by this method. Preliminary results of a study of a Penning-ion-gage source of multiply charged ions for atomic collision experiments are reported. Ions produced and detected to date include Ar^+, Ar^{2+}, Ar^{3+}, CO^+, CO_2^+, O_2, He^+, and He^{2+}. (A.G.W.)

39459 LOW INTENSITY VERSATILE LABORATORY ION SOURCE. Buehler, D.; Voinov, M.; Tannenberger, H. (Geneva Research Center). Vacuum; 22: No. 2, 61(Feb 1972).

A source of Ag, Au, Ni, Fe, Pt ions was constructed. The beam current is 10 nA for Pt and 100 nA for the other metals. The source was used to implant ions at energies from 50 eV to 3 keV. (auth)

39460 AVERAGE CHARGE OF HEAVY IONS STRIPPED IN GASES AND SOLIDS. Betz, Hans D. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 249-55(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A review is presented of extensive experimental data on average equilibrium charge states, $\bar{q}$, of heavy ions penetrating through gaseous and solid media at energies up to 180 MeV. The usefulness of various semiempirical methods to predict $\bar{q}$ is critically evaluated, and the extent to which these methods can be used for extrapolations into ranges where no measurements are available is discussed. Existing theoretical models are examined in detail, and it is shown that the criterion by Bohr and Lamb is well suited to predict $\bar{q}$ with good accuracy in gaseous targets. A brief discussion is presented concerning the influence of the density of stripper targets on $\bar{q}$. (auth)

39461 HEAVY ION STRIPPING BY SOLID FOILS BETWEEN 1 AND 6 MeV/NUCLEON. Baron, Eric (Institut de Physique Nucleaire, Orsay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 256-62(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Equilibrium charge distributions of 1-MeV/nucleon Ne, Ar, and Kr ions were measured at the end of the Orsay linac by using a Faraday cup. The same measurements were made for Kr at 4 MeV/nucleon and for Ar and Kr at 6 MeV/nucleon with the help of solid-state detectors on the ALICE beam. In the last case (Kr), the nonequilibrium distribution is also given for carbon thicknesses ranging from 10 to 200 $\mu g/cm^2$. (10 figures, 2 tables) (auth)

39462 LIFETIME OF CARBON FOILS BOMBARDED BY 4-MeV Ni. Yntema, J. L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 272-3(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

A study of some of the causes of foil failure and procedures to reduce their effects is reported. It was found that the lifetime of the foil is strongly affected by radiation damage and electrostatic forces. These effects can be controlled to a reasonable extent by increasing the temperature of the foil during bombardment and by evaporating a thin layer of conducting material on the foil. The results do not show any appreciable changes at the beam spot, except for a contraction, which may be due to radiation annealing. The limiting factor at present is the appearance of cracks near the edge of the foil holder: control of the dominant factor in the appearance of the cracks should result in a further significant improvement of the lifetime. (R.W.R.)

39463 CHARGE FRACTIONS AND EXCITED-ATOM POPULATIONS OF 8- TO 100-keV DEUTERIUM BEAMS EMERGING FROM SOLID FILMS OF C, Mg, Nb, AND Au. Berkner, Klaus H.; Bornstein, Isaac; Pyle, Robert V.; Stearns, J. Warren (Univ. of California, Berkeley). Phys. Rev., A; 6: No. 1, 278-88 (Jul 1972).

Charge-state fractions and yields of highly excited deuterium atoms produced by electron capture when 8- to 100-keV deuterons emerge from C, Mg, Nb, and Au surfaces deposited on thin carbon foils under high-vacuum conditions are reported. Atoms with principal quantum number $n = 6$ were detected with an optical technique; atoms in the levels $n \approx 12$ to 18 were detected by ionizing them in a strong electric field. Changes with time after evaporation, presumably due to contamination of the surfaces, were observed. The experimental results are compared with available theoretical estimates. Solid and vapor targets are compared for Mg. (auth)

39464 CHARGE STATES OF 29.2- TO 45.7-MeV URANIUM IONS EMERGING FROM SOLID FOILS. Brown, M. D. (Oak Ridge National Lab., Tenn.). Phys. Rev., A; 6: No. 1, 229-33 (Jul 1972).

The equilibrium-charge-state distributions of uranium ions were measured in carbon at 29.2 and 45.7 MeV, in aluminum at 29.1 MeV, in silver at 29.7 MeV, and in gold at 29.6 MeV (energy is the exit-beam energy). Following the passage of monoenergetic uranium ions from the Oak Ridge tandem accelerator through each thin-foil target, the charge states in the emergent beams were spatially separated in an electrostatic analyzer and measured with a position-sensitive surface-barrier detector. The foil thicknesses, derived from α-particle energy-loss measurements, were 34 $\mu g/cm^2$ for carbon, 51 $\mu g/cm^2$ for aluminum, 58 $\mu g/cm^2$ for silver, and 110 $\mu g\ cm^2$ for gold. Non-Gaussian charge-state distributions were observed. The most probable charge states are in reasonable agreement with published semiempirical formulas, although some deviations are noted. (auth)

39465 COLD SURFACE IONIZATION OF FAST K ATOMS ON Ta AND W RIBBONS. Cuderman, J. F. (Sandia Labs., Albuquerque, N. Mex.). Surface Sci.; 28: No. 2, 569-73(Dec 1971).

Absolute efficiencies for ionization of fast K atoms on ribbons of Ta and W at ambient temperature are reported for K atoms incident with energies between 10 and 1000 eV. (auth)

39466 EJECTION OF ELECTRONS FROM MOLYBDENUM AND TUNGSTEN BY KILO-ELECTRON-VOLT POTASSIUM IONS. Breunig, James L. (Univ. of California, Berkeley). Phys. Rev., B; 6: No. 3, 687-94(1 Aug 1972).

The experimental coefficient of ion–electron emission for K^+ in the 0.6- to 6-keV energy range incident on pure Mo was found to be in excellent qualitative and numerical agreement with the calculation by Parilis and Kishinevski. Sharp thresholds were measured at, respectively, 0.59 and 0.64×10^7 cm/s for Mo and W. Evidence involving the distribution in energy of electrons ejected at angles near the target normal showed that incident-beam particles embedded in the target fundamentally affect the nature of the ejection process. This contamination factor is basically the cause of the discrepancy between the new and previous data. In particular, the linear intercept for Mo differs by 50% from Brunnée's value. Pulse measurement techniques were used, and pure Mo surfaces were prepared by subliming away contaminated metal layers at 2000°K. The electron emission for K^+ on Mo was found to be augmented by monolayer coverage of pure Mo by N_2 at low energies but was reduced slightly at incident energies above 3 keV. This observation is discussed in terms of the surface-barrier effect on escaping electrons. (auth)

39467 PRECISION MEASUREMENTS ON THE ANGULAR AND TEMPERATURE DEPENDENCE OF SPUTTERING. Elich, J. J. Ph.; Roosendaal, H. E.; Onerdelinden, D. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Radiat. Eff.; 14: No. 1-2, 93-10(May 1972).

Sputtering ratios of 20-keV Ar^+ and Ne^+ bombardment of (100) and (111) Cu crystals were determined as a function of the angle of incidence at the target temperature 303°K and at a target temperature in the vicinity of 130°K. The angular behavior of the sputtering ratio in the neighborhood of a low index direction can be described with Onderdelinden's model. The influence of the temperature of the target on sputtering was found to be largest for angles between the low index direction and the critical angle. (auth)

39468 INVESTIGATION OF THE VELOCITY SPECTRUM OF EXCITED PARTICLES BY FAST IONS FROM A SOLID AS A MEANS TO STUDY ITS ELECTRONIC LEVEL STRUCTURE. Gritsyna, V. V.; Kiyan, T. S.; Koval, A. G.; Fogel, Ya. M. (Kharkov State Univ.). Radiat. Eff.; 14: No. 1-2, 77-9(May 1972).

It is shown that by measurement of the velocity of excited particles ejected by a beam of fast ions from the surface of a solid, some characteristics of its electronic level structure may be determined. The velocity spectrum of Ti, Na, and Li atoms ejected, respectively, from targets of titanium and NaCl and LiF crystals by a beam of Ar^+ ions was investigated. From an analysis of the obtained velocity spectra it was deduced that the work function of Ti must lie in the energy interval 3.8 to 4.15 eV, and that the width χ of the conductivity bands of NaCl and LiF has the value $\chi_{NaCl} \geq 1.019$ eV and $\chi_{LiF} \leq 0.381$ eV. (auth)

39469 SECONDARY ELECTRON SPECTRA OF SOME SOLID TARGETS UNDER IONIC BOMBARDMENT. Louchet, F.; Viel, L.; Benazeth, C.; Fagot, B.; Colombie, N. (Univ. Paul Sabatier, Toulouse). Radiat. Eff.; 14: No. 1-2, 123-30(May 1972).

Energy spectra of secondary electrons emitted by ion-bombarded targets show the presence of Auger electrons and of two or three characteristic losses attributed to surface plasmon excitations. Diabatic correlation diagrams for asymmetric collisions can be used for the determination of the deep holes involved in the Auger transitions. In the case of a Be target, they are in good agreement with the dependence of the Auger intensities upon the nature of the incident ion. (auth)

39470 OPTIMIZATION OF ION-SOURCE CHAMBER GEOMETRY. Grigor'ev, Yu. P.; Morozov, P. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1926-8(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2428-30(Nov 1971).

An optimization of the geometric dimensions of an ion source is realized which provides maximum ion current. Assuming a constant primary electron current density and uniform distribution of ion current at the chamber walls, it is found that the optimum ratio between chamber depth and width is in the neighborhood of 0.5. For a uniform ion-beam current density the length of the chamber should be of the same order of magnitude as the ionization range of a primary electron. (auth)

Atomic and Molecular Properties

Refer also to abstracts 39125, 39530, 39534, and 40186.

39471 (SC-CR—723151-A) THEORETICAL TRANSITION PROBABILITIES FOR THE $2p\pi_u$-$1s\sigma_g$ AND $2p\pi_u$-$3d\sigma_g$ TRANSITIONS IN H_2^+. Shafi, M.; Beckel, Charles L.; Wu, Fun-Min (New Mexico Univ., Albuquerque). [nd]. 14p. (CONF-720608—1). Dep. NTIS.

From Meeting of the American Physical Society, Albuquerque, NM. (5 Jun 1972).

Accurate electronic transition moments R_e as a function of nuclear separation r are calculated for the $2p\pi_u - 1s\sigma_g$ and $2p\pi_u - 3d\sigma_g$ transitions in H_2^+. The R_e's are then combined with vibration—rotation wave functions to determine numerically band strengths for many combinations of vibrational quantum numbers v′ and v″. Effects of the variation of R_e with r and the dependence of band strength on rotational quantum number are investigated. (auth)

39472 EXACT ELECTROMAGNETIC MATRIX ELEMENTS AND EXACT SELECTION RULES FOR HYDROGENIC ATOMS. Moses, H. E. (Air Force Cambridge Research Labs., Bedford, Mass.). Lett. Nuovo Cim.; 4: No. 2, 51-3(13 May 1972).

A method of obtaining exact matrix elements of the electromagnetic interaction is based upon introduction of the expansion of the electromagnetic vector potential in terms of an angular momentum basis. Exact selection rules follow from this result. Exact matrix elements for some special cases, including emission of Ly-α and Ly-β radiation from hydrogen and the electromagnetic shift of the ground state of hydrogen, are given. (A.G.W.)

39473 ULTRAVIOLET CONVERGENCE OF THE ELECTROMAGNETIC CORRECTION TO THE GROUND-STATE ENERGY OF HYDROGEN. Hoffman, H. S.; Moses, H. E. (Air Force Cambridge Research Labs., Bedford, Mass.). Lett. Nuovo Cim.; 4: No. 2, 54-7(13 May 1972).

It is shown that the ultraviolet catastrophe in the second-order calculation of the shift of the energy levels of the hydrogen atom due to the interaction of the atom with the quantized electromagnetic field is due to the approximate way that the matrix elements of the electromagnetic interaction are calculated, particularly to the neglect of retardation. When previously described exact matrix elements, including the effects of retardation, are used in the expressions for the second-order shift, the integrals that appear converge strongly for high photon frequency. (A.G.W.)

39474 IMPROVED STARK-PROFILE CALCULATIONS FOR THE He II LINES AT 256, 304, 1085, 1216, 1640, 3203, AND 4686 A. Kepple, Paul C. (Univ. of Maryland, College Park). Phys. Rev., A; 6: No. 1, 1-9(Jul 1972).

The frequency distributions of the He II lines at 256, 304, 1085, 1216, 1640, 3203, and 4686 Å, broadened by the local fields of both ions and electrons in a plasma, are calculated in the classical-path approximation. The calculations for the electron broadening are based on an impact theory that accounts for perturbations to both upper and lower levels of the radiating ion. The theory allows (approximately) for the level splitting caused by the fields of the (perturbing) ions, finite duration of the collisions, screening of the electron fields, and includes (approximately) the effects of inelastic collisions. The effect of perturbations by singly charged ions is calculated in the quasi-static linear Stark-effect approximation using Hooper's microfield distribution functions. Comparison to previous calculations shows fair agreement with some increase in linewidth. Comparison with experimental results is less conclusive. Fair agreement is found with some results, but others reveal a discrepancy of as much as a factor of 2 in the line wings. (auth)

39475 RELATIVE ENERGIES OF THE LOWEST LEVELS OF THE f^qps^2, f^qds^2, AND $f^{q+1}s^2$ ELECTRON CONFIGURATIONS OF THE LANTHANIDE AND ACTINIDE NEUTRAL ATOMS. Vander Sluis, K. L.; Nugent, L. J. (Oak Ridge National Lab., Tenn.). Phys. Rev., A; 6: No. 1, 86-94(Jul 1972).

Linearization of the differences between the lowest levels of the f^qps^2, f^qds^2, and $f^{q+1}s^2$ electron configurations as a function of q is demonstrated for the lanthanide and actinide series. A linear extrapolation of these differences estimates the energy of the lowest level of the $4f^{14}6p6s^2$ electron configuration of Lu to be 3.5×10^3 cm^{-1} higher than the measured value. This deviation from linearity is attributed to expected discontinuities at $q = 0$ and 14 ends of the f^qds^2 series. In the actinide series the corresponding linear extrapolation predicts the lowest level of the $5f^{14}7p7s^2$ electron configuration of Lr to be $(2.3 \pm 3) \times 10^3$ cm^{-1} above the expected $5f^{14}6d7s^2$ ground state, after correction for a corresponding 3.3×10^3 cm^{-1} deviation expected at the end of the actinide series. (auth)

39476 BRUECKNER—GOLDSTONE MANY-BODY PERTURBATION CALCULATION OF HELIUM PHOTOIONIZATION. Ishihara, T.; Poe, R. T. (Univ. of California, Riverside). Phys. Rev., A; 6: No. 1, 116-20(Jul 1972).

A calculation is carried out within the framework of the Brueckner—Goldstone many-body perturbation approach for the photoionization of helium. In particular, a newly developed technique of multiple basis sets was used to circumvent the difficulty of evaluating the singular integrals that appear in the important final-state correlation. This technique also makes possible considerable calculational simplicity, reducing the final evaluation to only two diagrams. The result agrees well with the accurate experimental data of Samson. (auth)

39477 D AUTOIONIZATION STATES OF He AND H. Bhatia, A. K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A; 6: No. 1, 120-4(Jul 1972).

Positions of the lowest $^{1,3}D^e$ autoionization states of He and H^- below the n = 2 level of He^+ and H were calculated variationally using Feshbach's Q-operator formalism. The trial wave function is of the Hylleraas type with appropriate angular momentum factors. The widths and the shifts of the states were also calculated. The shifts are found to be positive for all the states calculated here. The results with 112 terms for most states are lower than any previously calculated. The calculated lowest autoionization states of He and H^- (relative to the ground states of He and H, respectively) are 59.902 and 10.1185 eV, in good agreement with the observed values of 59.9 and 10.13 ± 0.015 eV. (auth)

39478 ANGULAR DISTRIBUTIONS OF PHOTOELECTRONS FROM H_2: EFFECTS OF ROTATIONAL AUTOIONIZATION. Dill, Dan (Univ. of Chicago). Phys. Rev., A; 6: No. 1, 160-72(Jul 1972).

Fano's theory of photoabsorption by H_2 near the ionization threshold is extended to yield photoelectron angular distributions above as well as between the ionization thresholds for alternative rotational states of the H_2^+ ion. In accordance with recent measurements, the angular distribution of direct photoionization is quite different depending on whether or not the ionization is accompanied by a rotational transition. In the autoionization range between rotational thresholds the angular distribution oscillates along each Rydberg line of the rotational autoionization spectrum, resulting in Beutler–Fano resonance profiles that depend strongly on angle of observation. The results are compared with available experimental data. Angular distributions provide very sensitive tests of the theory. The calculation may serve as a basis for extensions to electronic and vibrational autoionization processes. (auth)

39479 TIME-DEPENDENT THEORY OF STARK QUENCHING OF 2S STATES IN HYDROGEN AND HELIUM. Holt, Helen K. (National Bureau of Standards, Washington, D. C.); Sellin, I. A. Phys. Rev., A; 6: No. 1, 508-12(Jul 1972).

A nonperturbative time-dependent theory that gives Stark-quenching lifetimes in agreement with experiment for both one- and two-electron 2S states is presented. This theory differs from the conventional Bethe–Lamb theory of Stark quenching, but reduces to this older theory, for one-electron atoms only, when a well-known sum rule is applied. (auth)

39480 HYPERFINE TEMPERATURE SHIFT OF DEUTERIUM IN NEON AND ARGON. Wright, John J. (Univ. of New Hampshire, Durham). Phys. Rev., A; 6: No. 1, 524-5(Jul 1972).

The temperature dependence of the hyperfine frequency of deuterium in neon and argon buffer gases was measured over the range −100 to + 300°C. From a linear least-squares fit to the data, the shifts at constant buffer-gas density were found to be $(2.9 \pm 0.4) \times 10^{-3}$ Hz/°K torr in neon and $(3.1 \pm 0.5) \times 10^{-3}$ Hz/°K torr in argon. (auth)

39481 COULOMB GREEN FUNCTION IN THE x-REPRESENTATION AND THE RELATIVISTIC POLARIZABILITY OF HYDROGEN ATOM. Zon, B. A.; Manakov, N. L.; Rapoport, L. P. (Voronezh State Univ., USSR). Yadern. Fiz.; 15: No. 3, 508-17 (Mar 1972). (In Russian).

A representation is obtained of the relativistic Coulomb Green function in the form of a Laguerre polynomial expansion found to be very convenient in application. The Green function of two-component fermion theory and the reduced Green function are constructed. Nonrelativistic limits are examined. A closed analytic expression for the static relativistic polarizability of a hydrogen atom is obtained. (auth)

39482 GEOMETRY AND DISSOCIATION ENERGY OF He_3^+. Vauge, C. (Institut d'Electronique Fondamentale, Orsay, France); Whitten, J. L. Chem. Phys. Lett.; 13: No. 6, 541-4(15 Apr 1972).

Main features of the recently observed triatomic helium ion He_3^+ are investigated, using self-consistent-field and configuration-interaction treatments with a reasonably detailed basis set of gaussian orbitals. The ion geometry is found to be linear and symmetrical (nuclear spacing: 2.33 bohr). The calculated vibrational constants of the three fundamental modes are in satisfactory agreement with the only previously reported calculation. The present value of the dissociation energy (D_0 = 0.0 eV) is smaller than Patterson's experimental determination (0.17 eV). (auth)

39483 X-RAY AND PHOTOELECTRON SPECTROSCOPY FOR THE DETERMINATION OF 4f ENERGIES OF RARE EARTHS. Bonnelle, C. (Univ., Paris); Karnatak, R. C.; Joergensen, C. K. Chem. Phys. Lett.; 14: No. 2, 145-9(15 May 1972).

The energy and the effects of interelectronic repulsion of the 4f shell in metallic lanthanides and their oxides are discussed, based on recent measurements of x-ray and photoelectron spectra. (auth)

39484 NONADDITIVE EFFECTS IN THE FIRST-ORDER INTERACTION ENERGY OF HYDROGEN ATOMS. Kolos, W.; Les, A. (Univ., Warsaw). Chem. Phys. Lett.; 14: No. 2, 167-9(15 May 1972).

First-order three- and four-body contributions to the interaction energy of 3 and 4 hydrogen atoms in their repulsive states of highest multiplicity were calculated. In the case of H_4 the multibody expansion of the interaction energy converges slower for a square than for a tetrahedral configuration of the atoms. Relations between various multibody terms and overlap integrals are discussed. (auth)

39485 CHARACTER OF THE LEAST-ENERGY TRAJECTORY NEAR THE SADDLE POINT ON H_3 POTENTIAL SURFACES. Silver, David M. (Johns Hopkins Univ., Silver Spring, Md.). J. Chem. Phys.; 57: No. 1, 586-7(1 Jul 1972).

It is pointed out that the least-energy trajectories on the Porter–Karplus and other semi-empirical potential surfaces do not contain kinks at the saddle point as previously reported. To substantiate this point, least-energy reaction paths for four different potential surfaces are shown in a figure. (A.G.W.)

39486 LINEAR SYMMETRIC H_4. Bender, Charles F. (Univ. of California, Livermore); Schaffer III, Henry F. J. Chem. Phys.; 57: No. 1, 217-20(1 Jul 1972).

Ab initio calculations were carried out for the lowest $^1\Sigma_g^+$ state of H_4. A contracted Gaussian basis set of two s and one p functions centered on each atom was used. Self-consistent-field (SCF), SCF plus all singly and doubly excited configurations, and full configuration-interaction (2172 configurations) calculations were carried out. The results may be pertinent both to the H_2 + D_2 reaction and the problem of the linear antiferromagnetic chain. It is predicted that two H_2 molecules may approach to within 1.6 bohr with an energy only 43 kcal above that of the separated molecules. A van der Waals attraction of 22°K is predicted at H_2–H_2 center of mass separation 7.1 bohr. Equidistant H_4 is predicted to have lowest energy at 1.67 bohr, lying 7.1 eV below the exact energy of four H atoms but 44 kcal above two H_2 molecules. The electronic structure of linear equidistant H_4 is discussed as a function of H–H separation and no evidence of a Mott transition is found. (auth)

39487 SPHERICAL LIMIT OF H_2^+: A SYMMETRY DILEMMA. Katriel, J. (Nuclear Research Centre Negev, Beer Sheva, Israel). Int. J. Quant. Chem.; 6: No. 3, 541-8(May 1972).

The spherical limit of H_2^+ is studied as an example of the occurrence of a symmetry dilemma of a kind that is a general characteristic of truncated one-center expansions. At internuclear distances just somewhat larger than the equilibrium distance the best spherical approximation turns out to be centered off the molecular midpoint and is thus a mixture of σ_g and σ_u. Rather detailed insight into the situation is gained by an analysis based on the electrostatic Hellmann–Feynman theorem. (auth)

39488 LONG-RANGE INTERACTION BETWEEN TWO HYDROGEN ATOMS. Deal, Walter J. (Univ. of California, Riverside). Int. J. Quant. Chem.; 6: No. 3, 593-6(May 1972).

Previous calculations of interaction energy were repeated using double-precision arithmetic. Results having several additional significant figures are tabulated and compared with the previous results. (A.G.W.)

39489 CALCULATION OF MEAN EXCITATION ENERGY FOR ALL ELEMENTS. Chu, W. K.; Powers, D. (Baylor Univ., Waco, Tex.). Phys. Lett.; 40A: No. 1, 23-4(19 Jun 1972).

The mean excitation energy I in the stopping power is calculated using Lindhard and Scharff's theory with a Hartree–Fock–Slater charge distribution. The calculation I/Z versus atomic number Z reveals structure as observed in many experiments. (auth)

39490 CASCADE-INDUCED ALIGNMENT CHANGES OF INTENSITY-DECAY CURVES. Berry, H. G.; Curtis, L. J.; Subtil, J. L. (Univ., Lyon). J. Opt. Soc. Amer.; 62: No. 6, 771-3(Jun 1972).

Effects of changes of alignment of an atomic level due to cascading are studied as a function of time after excitation. For many of the decays observed in beam-foil spectroscopy, the cascade-induced alignment is expected to be close to zero. Accordingly, it was found that the difference between multiexponential decay curves measured in light polarized parallel and perpendicular to the beam may contain only a single exponential characteristic of the level lifetime, thus providing a cascade-free lifetime measurement. By similar considerations, alignment information was also used to reduce or eliminate unresolved blending in lifetime measurements. Results are reported for He^+ and Li^+ beams on C foils. (auth)

39491 QUASI-STATIONARY STATES OF HYDROGEN. Marx, Egon (Drexel Univ., Philadelphia). Int. J. Theor. Phys.; 5: No. 4, 251-62(1972).

The hydrogen atom is considered within the context of a theory of relativistic quantum mechanics that allows for a probabilistic interpretation of the wave function. The radial equation that determines the energy levels of bound states, represented by quasi-stationary states is found. The order of magnitude of the shifts from the usual spectrum obtained from the Dirac equation is computed, and it is found that the leading terms for these corrections are of the order of $\alpha^6 \log \alpha$ for s-states and α^6 for other states. They are small compared to the Lamb shift, which is of the order of $\alpha^5 \log \alpha$. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 39585 and 39613.

39492 POSITRONIUM-NEGATIVE-ION FORMATION IN MOLECULAR HYDROGEN. Mukherjee, S. C.; Sural, D. P. (Indian Association for the Cultivation of Science, Jadavpur, India). Phys. Rev., A; 6: No. 1, 125-9(Jul 1972).

The cross sections for positronium-negative-ion formation by double electron capture in molecular hydrogen are calculated by the Born approximation for incident positron energies ranging between 45 and 500 eV. The maximum of the cross section occurs at about 60 eV, and thereafter the cross section decreases rapidly with an increase in incident energy. (auth)

39493 POSITRON LIFETIMES IN PURE AND DOPED ICE AND IN WATER. Eldrup, M. (Danish Atomic Energy Commission Research Establishment, Risoe); Mogensen, O.; Trumpy, G. J. Chem. Phys.; 57: No. 1, 495-504(1 Jul 1972).

Positron lifetime spectra were measured in mono- and polycrystalline light ice, polycrystalline heavy ice, and doped light ice, as well as in light and heavy water. All spectra were resolved into three components. At temperatures between −196° and −100°C the lifetimes and relative intensities are virtually constant, being 0.12 ns and 20%, 0.44 ns and 28%, 0.68 ns and 52%, and attributed to annihilation of para-Ps, free positrons, and ortho-Ps, respectively. Above −100°C the longest lifetime increases with temperature to 1.1 ns at 0°C. Its relative intensity is unchanged, and the parameters for the other components show a complex behavior. The spectra for mono- and polycrystalline light ice and for polycrystalline heavy ice are identical. For water long-lifetime components attributed to ortho-Ps are 1.86 ns, 27% for H_2O and 2.01 ns, 22% for D_2O. Theoretical explanations are suggested. Fast frozen solutions of HF with concentrations larger than approximately 10^{-5} mole fraction have a lifetime component at −160°C of 1.23 ns, 52% attributed to trapping of ortho-Ps in amorphous regions. Very good agreement is found between the experiments and a trapping model. Irreversible changes of the spectra are found by heating above approximately −120°C. Measurements on a number of fast frozen aqueous solutions of acids, bases, and salts are reported, none of them showing as strong influence on the ortho-Ps lifetime as HF. (auth)

Collision Phenomena

Refer also to abstracts 38559, 39063, 39335, 39458, and 39492.

39494 (ANL-7939) MOMENTUM TRANSFER CROSS SECTIONS FOR ELECTRON COLLISIONS ON ATOMS AND MOLECULES AND THEIR APPLICATION TO EFFECTIVE COLLISION FREQUENCIES. Itikawa, Yukikazu (Argonne National Lab., Ill.). Apr 1972. Contract W-31-109-eng-38. 32p. Dep. NTIS.

Experimental and theoretical data on the momentum-transfer cross section were collected for electron collisions with H, He, O, Ne, Ar, Kr, Xe, Cs, Hg, H_2, N_2, O_2, CO, NO, H_2O, CO_2, N_2O, NH_3, and CH_4. The best values are presented graphically as functions of the electron energy over the range from 0.01 to 10 eV. From these data the effective collision frequencies of electrons are calculated; they are tabulated for the electron temperatures from 100 to 5000°K. (3 tables, 19 figures, 49 references) (auth)

39495 LEVEL-CROSSING EXPERIMENTS ON SOME HELIUM STATES EXCITED BY ION IMPACT. Buchhaupt, Klaus (Justus-Liebig-Univ., Giessen, Ger.). Z. Naturforsch.; 27a: No. 4, 572-9 (Apr 1972). (In German).

With hydrogen and helium ions, respectively, Hanle-effect experiments were performed on impact excitation into the helium states 3^3P, 4^3P, 5^3P, 3^3D, 4^3D, 3^1D, 4^1D, and 5^1D. The width of the orientation signals of the Hanle effect was measured as a function of helium pressure in the impact chamber. The pressure dependence of the signal width permitted determination of the natural life expectancy and the cross section for destruction of orientation. Values for excitation by helium ions are tabulated. It is concluded that for the states 4^1D and 5^1D, an impulse transfer occurred during ion impact excitation. (tr-auth)

39496 LEVEL-CROSSING EXPERIMENTS WITH EXCITED BEAMS. Bachmann, W.; Janke, W. (Univ., Giessen, Ger.). Z. Naturforsch.; 27a: No. 4, 579-82(Apr 1972). (In German).

Impact interaction between a helium ion and a neon atom leads, aside from other effects, to electron capture into an excited partially oriented helium state. By means of the Hanle effect, the width of the 4^1D helium state excited through electron capture was measured in its dependence on both neon gas pressure and velocity of helium atoms. From the results, velocity dependence of cross sections for elimination of the orientation effect in the excited helium atoms through collision with neon atoms was determined. In the energy range from 5 keV to 30 keV, the cross section was inversely proportional to velocity. As an additional result, the natural lifetime of the 4^1D state was found to be (38.4 ± 2.1) ns. (H.B.G.)

39497 CHARGE-CHANGE CROSS SECTIONS OF HIGHLY CHARGED 5 TO 50 MeV IODINE IONS. Angert, N.; Franzke, B.; Grundinger, U.; (and others) (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 263-5(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Cross sections of I^{4+} and I^{18+} for electron capture and loss were measured in N_2 and Ar at low pressure. It was found that the dependence of capture cross sections on charge and velocity is strongly influenced by the atomic structure of the ion. The applicability of simple classical models for the capture process was investigated. (auth)

39498 CHARGE EXCHANGE OF FAST IODINE IONS IN A DENSE JET OF CARBON DIOXIDE. Franzke, B.; Angert, N.; Schmelzer, Ch. (Gesellschaft fuer Schwerionenforschung mbH, Darmstadt, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 266-71(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Charge distribution measurements were made with 10- to 75-MeV iodine ions of various incident charge states traversing either a supersonic CO_2 jet of variable density in the range 5×10^4 to 1.5×10^{17} molecules/cm^3 or a target of dilute CO_2 with a maximum density of 5×10^{14} molecules/cm^3. The equilibrium mean charge $\bar{\xi}_\infty$ of the iodine ions in the jet is found to be higher than in the dilute gas. The maximum difference of about one charge unit is observed at 75 MeV. There is no indication for a further increase of $\bar{\xi}_\infty$ at gas densities above 5×10^{16} molecules cm^3. Cross sections for electron capture and loss were determined by means of a least-squares evaluation of nonequilibrium charge distributions. Considerable decrease of the capture cross sections for some lower charge states has proved to be responsible for the increase of $\bar{\xi}_\infty$, whereas the loss cross sections do not change measurably with increasing target density. (6 figures, 3 tables) (auth)

39499 THEORY OF ELECTRON–MOLECULE COLLISIONS BY FRAME TRANSFORMATIONS. Chang, E. S. (Univ. of Chicago. Univ. of Massachusetts, Amherst); Fano, U. Phys. Rev., A; 6: No. 1, 173-85(Jul 1972).

Laboratory-frame and body-frame treatments are combined using the l-uncoupling transformation, which had served to interpret the absorption spectrum of H_2. Application of a phase–amplitude procedure converts the Schrödinger equation to a Volterra-type integral form, which reduces to a Born-like approximation when the long-range interactions are weak. Attention is directed to features of low-energy collisions that must be considered by a realistic theory. A formalism that can take advantage of different simplifying factors in different ranges of the electron–molecule distance is developed. Detailed developments and applications are deferred. (auth)

39500 ANGULAR MOMENTUM TRANSFER IN THE THEORY OF ANGULAR DISTRIBUTIONS. Fano, U.; Dill, Dan (Univ. of Chicago). Phys. Rev., A; 6: No. 1, 185-92(Jul 1972).

The angular distribution of collision products is expressed as a sum of incoherent contributions corresponding to different magnitudes of the angular momentum $\vec{j}_t$ transferred to an unpolarized target. For targets with a characteristic internal reference frame (e.g., molecules) the coefficients of this sum are interpreted as generalized $2^{j}t$-pole polarizabilities of the target in its internal reference frame, analogous to the scalar and quadrupole polarizabilities that determine the Raman effect. The theory is developed in the context of photoionization, but is applicable to more general collision processes as well. It is illustrated by use and extension of diagrammatic techniques. (auth)

39501 ELECTRON EXCITATION OF THE SODIUM D LINES. Enemark, E. A.; Gallagher, Alan (Univ. of Colorado, Boulder). Phys. Rev., A; 6: No. 1, 192-205(Jul 1972).

The electron excitation of the sodium resonance lines (D lines) was measured in the energy range from threshold to 1000 eV. The electron-beam full width at half-maximum was ~$\frac{1}{3}$ eV, and the sodium-beam optical depth was small and varied. After correction for minor cascade contributions and the measured polarization, the excitation function was normalized to the Born theory in a high-energy limit where the energy dependence converges to the theoretical behavior. The resulting normalized cross section and the polarization are in excellent agreement with recent close-coupling calculations for the energy region from threshold to 5 eV. (auth)

39502 MOLECULAR-ORBITAL CALCULATIONS ON INELASTIC Ne—Ne$^+$ COLLISIONS. Thulstrup, E. W. (Univ. of Aarhus, Denmark); Johansen, H. Phys. Rev., A; 6: No. 1, 207-10(Jul 1972).

A series of ab initio Hartree—Fock calculations were performed for the systems Ne_2, Ne_2^+, and Ne_2^{++} for different values of the interatomic distance R. Satisfactory convergence was reached for R ≥ 1 au. For R < 1 au, molecular-orbital energies were determined from a united-atom approximation. From the total energies and from energies of occupied and nonoccupied orbitals approximated-diabatic-potential curves were obtained for a large number of excited states of the Ne_2^+ system. The approximations used were checked by comparison with the results of open-shell Hartree—Fock calculations on Ne_2^+. The potential-energy curves obtained show that there are energetical possibilities for new assignments of the inelastic energy losses observed in nonviolent Ne—Ne$^+$ collisions. These assignments are able to explain observations that cannot be described by the models proposed earlier. (auth)

39503 EXTENSION OF THE ELECTRON-PROMOTION MODEL TO ASYMMETRIC ATOMIC COLLISIONS. Barat, M. (Paris Univ., Orsay, France); Lichten, W. Phys. Rev., A; 6: No. 1, 211-29(Jul 1972).

The electron-promotion model is extended to include asymmetric atomic collisions. Diabatic correlations are made between the limits of united and separated atoms. The effects of core penetration are taken into account. The model is especially applicable to the case of inner-shell promotion. The promotion model agrees with the results of Specht, which show that promotion of electrons occurs when an energy level of one atom matches that of another. A detailed discussion of L-shell excitation is given. The model accounts in detail for the subshell-excitation effects and lack of reciprocity found between target and projectile by Kavanagh et al. The effects of outer-shell vacancies are felt in inner-shell excitation through the opening or closing of exit channels. In particular, the "solid effect" opens channels leading to outer-shell orbitals of the projectile. The Kessel model is applied to L-shell excitations in asymmetric collisions. The possibility of exciting both collision partners with nearly matching levels is taken into account. Two parameters are needed to fit the total cross section for excitation as a function of atomic number: the critical internuclear distance for a given pair of atoms and the effective range over which the promotion takes place. The parameters needed to fit the total-cross-section data of Cu on targets of different Z, taken by Kavanagh et al., agree with the differential-energy-loss and x-ray data, obtained by Fastrup et al. and by Saris, from different atoms scattered by atomic argon targets. (auth)

39504 ELECTRON TRANSMISSION SPECTROSCOPY: CORE-EXCITED RESONANCES IN DIATOMIC MOLECULES. Sanche, L.; Schulz, G. J. (Yale Univ., New Haven). Phys. Rev., A; 6: No. 1, 69-86(Jul 1972).

A high-resolution and high-sensitivity electron transmission spectrometer is used to study sharp structures in the total scattering cross section of H_2, D_2, O_2, NO, N_2, and CO. Many new resonances are found, some of which form bands that consist of progressions of negative-ion vibronic states. The existence of bands makes the identification of temporary negative-ion states easier, since the spacing and the magnitudes of the structure can be compared with the appropriate parameters of various positive-ion cores. The most prominent features observed consist of two Rydberg electrons attached to a particular positive-ion core. (auth)

39505 APPLICATION OF THE QUASI-MINIMUM PRINCIPLE TO CALCULATIONS ON ELECTRON SCATTERING BY ATOMIC HYDROGEN. Truhlar, Donald G.; Smith, Richard L. (Univ. of Minnesota, Minneapolis). Phys. Rev., A; 6: No. 1, 233-9(Jul 1972).

Variational lower bounds are calculated for the phase shifts for e^-—H scattering using algebraic procedures. This is the first numerical application of Hahn's recent quasi-minimum principle (QMP). The basis-function-expansion approach to the close-coupling method is used to compute the phase shifts. It is found that the QMP is a useful principle for obtaining a bound using the Nesbet and minimum-norm algebraic variational principles but that the monotonic convergence may be lost using the Kohn and inverse-Kohn algebraic variational principles. (auth)

39506 SIMULTANEOUS IONIZATION AND EXCITATION OF NEON BY ELECTRON IMPACT. Walker, Keith G.; St. John, Robert M. (Univ. of Oklahoma, Norman). Phys. Rev., A; 6: No. 1, 240-50(Jul 1972).

The simultaneous ionization and excitation cross sections by electron impact for the 3p, 3d, and 4s levels in neon of the ^3P, ^1D, and ^1S cores were examined. The excitation functions were quite broad. In all, over 100 optical cross sections were measured and over 50 excitation functions from threshold to 1000 eV were obtained. The cascade lines from the 3d and 4s levels of the various cores were very weak, with some at the limit of detectability. The cascade lines from the 3d and 4s levels of the various cores were very weak, with some at the limit of detectability. The error of these cascade cross sections ranges from 10 to 50%. The direct-excitation cross sections were obtained for the 3p levels of the three cores. Polarization effects were examined; and only three levels exhibited any polarization; these were less than 10%. There are no previous experimental measurements of these cross sections. The branching ratios obtained by experiment and calculation are compared with those yielded by this work. These branching ratios, the lack of strong lines between doublet and quartet levels, and the general tendency of the quartet excitation functions to be more peaked than the doublets lead to acceptance of the (^3P)3p levels as being well-designated by LS coupling. In conjunction with this and the exceptionally broad excitation functions, it appears that the ionization cross section influences the energy dependence of the simultaneous ionization and excitation cross section. The high-energy portion of the excitation functions tended to bear this out as well. The sudden-perturbation approximation was applied to several of the 3p levels; its numerical values for the cross sections were two or three times greater than the experimental values. The cross section of most observed levels falls off with electron energy E as E^{-1}. Theory tends to indicate a (lnE)/E dependence at high energy. (auth)

39507 FREDHOLM OPTICAL-POTENTIAL CALCULATION OF ELASTIC ELECTRON—HYDROGEN-ATOM PHASE SHIFTS. Adelman, S. A.; Reinhardt, William P. (Harvard Univ., Cambridge, Mass.). Phys. Rev., A; 6: No. 1, 255-62(Jul 1972).

A Fredholm technique is used to compute elastic phase shifts for electron—hydrogen-atom scattering using the Feshbach optical potential. The method is noniterative and is computationally highly efficient as it allows computation of the Fredholm determinant $D(E + i\epsilon)$ at a series of energies from a single set of matrix elements of the optical potential. Scattering information is then obtained over a continuous range of energies by interpolation of $D(E + i\epsilon)$; resonance is easily located by inspection of the zeros of $\mathrm{Re}D(E + i\epsilon)$. (auth)

39508 1s—2p TRANSITIONS IN Mg BOMBARDED WITH 21-MeV OXYGEN IONS. McCrary, D. G.; Senglaub, M.; Richard, Patrick (Univ. of Texas, Austin). Phys. Rev., A; 6: No. 1, 263-8(Jul 1972).

A thick Mg target was bombarded by a 21-MeV oxygen-ion beam. Nine 1s—2p transitions were observed with an energy resolution of 1.26 eV. Relative to the 1253.6-eV $K\alpha_{1,2}$ reference energy, the energies of the other observed transitions in units of eV were 1261.5, 1268.5, 1270.7, 1273.3, 1281.0, 1283.0, 1293.0, and 1295.4. By comparing with Hartree—Fock—Slater calculations, the five groups of peaks were found to correspond to 1s—2p ($K\alpha$) transitions with initial configurations $(1s)^{-1}(2p)^{-n}$ for n = 0, 1, 2, 3, and 4. The transition for the $(1s)^{-1}(2p)^{-5}$ initial configuration was not observed in this experiment. This can be attributed to self-absorption in the target since the $(1s)^{-1}(2p)^{-5}$ $K\alpha$ transition energy lies above the K absorption edge. (auth)

39509 COULOMB T MATRIX AND THE PROTON—HYDROGEN CHARGE EXCHANGE. Shastry, C. S.; Rajagopal, A. K.; Callaway, J. (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 6: No. 1, 268-73(Jul 1972).

The proton—hydrogen charge-exchange amplitude is evaluated using the first-order terms in the Faddeev expansion for the corresponding transition operator. The new Coulomb T matrix derived recently by the authors is employed in computing the cross sections. For high energies of the incident proton, the Coulomb T matrix approaches the Coulomb potential to order $\nu^{-1} \ln \nu$ in contrast to the situation for a short-range potential ($\sim \nu^{-2}$). In the extreme high-energy limit the results of the first-order Faddeev–Watson approximation approach those of the Jackson–Schiff approximation. Explicit numerical calculation in the energy region 100 keV to 3 MeV shows that the cross sections lie in between those of the Brinkman–Kramers and Jackson–Schiff (JS) results and they approach the JS results from above. This is in contradistinction to previous work based on an incorrect form of the T matrix. (auth)

39510 CALCULATION OF TRANSITION PROBABILITIES USING THE LANDAU–ZENER MODEL. Nikitin, E. E.; Reznikov, A. I. (Inst. of Chemical Physics, Moscow). Phys. Rev., A; 6: No. 1, 522-3(Jul 1972).

The Landau–Zener formula is discussed in connection with numerical calculations of the nonadiabatic transition probability in atomic collisions. The present treatment in the case of weak interaction leads to an additional constant phase $\frac{1}{4}\pi$ beyond the semiclassical one and, in contrast to the conclusions of Olson and Smith, gives good agreement with their close-coupled and distorted-wave numerical results. (auth)

39511 COLLISION ENERGY DEPENDENCE OF ANGULAR DISTRIBUTIONS FOR VIBRATIONAL EXCITATION OF H_2 BY He. Micha, D. A. (Univ. of Florida, Gainesville); Rotenberg, M. Chem. Phys. Lett.; 13: No. 3, 289-91(1 Mar 1972).

Angular distributions for the vibrational excitation of H_2 by He were obtained assuming that H_2 is a rotationless anharmonic oscillator. A set of two coupled-channel scattering equations was solved for all orbital angular momenta, for the n = 0 to n = 1 transition. Increasing the collision energies from two to six times the first vibrational excitation energy changes intensities in the center of mass frame from backward peaked into forward peaked. (auth)

39512 ENERGY DEPENDENCE FOR Ne*($2p^53s^3P$) + Ar IONIZATION TOTAL CROSS SECTIONS. Olson, R. E. (Stanford Research Inst., Menlo Park, Calif.). Chem. Phys. Lett.; 13: No. 3, 307-9(1 Mar 1972).

The ionization (Penning and associative) total cross sections for Ne*($2p^53s^3P$) + Ar are calculated semiclassically in the energy range of 0.001 to 1000 eV and compared with recent experimental results of Micha et al. (Chem. Phys. Lett., 8: 587(1971)). (auth)

39513 INFLUENCE OF MOLECULAR ENVIRONMENT ON THE K-SHELL FLUORESCENCE YIELD OF CARBON IN SMALL MOLECULES. Harrison, K. G.; Tawara, H.; De Heer, F. J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Chem. Phys. Lett.; 14: No. 2, 285-7(15 May 1972).

The cross sections for carbon K x-ray emission were measured for 0.5- to 4-keV electrons incident on CH_4, C_2H_6, C_3H_8, C_2H_2, C_2H_4, CO, and CO_2. It is found that, although the cross sections per carbon atom show the same dependence on the incident electron energy, they differ in magnitude by up to 35%. This is interpreted as an effect of the molecular environment on the fluorescence yield. (auth)

39514 EFFECTIVE SEPARABLE APPROXIMATION FOR MULTICHANNEL GREEN'S FUNCTIONS. Wolken, G. Jr. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger.). Chem. Phys. Lett.; 14: No. 2, 249-54(15 May 1972).

The close-coupling approach to inelastic and reactive scattering is considered in the integral equation formulation. By approximating the integral by a finite quadrature, a finite Green's matrix $G(R_i, R_j)$ is obtained for each channel. Using He + H_2 inelastic scattering as an example, it is shown that the $G(R_i, R_j)$ matrix can be written as a sum of a small number of separable terms and still obtain an estimated accuracy of about 10%. Possible areas of application are also discussed. (auth)

39515 DISSOCIATIVE EXCITATION OF VACUUM ULTRAVIOLET EMISSION FEATURES BY ELECTRON IMPACT ON MOLECULAR GASES. III. CO_2. Mumma, M. J.; Stone, E. J.; Borst, W. L.; Zipf, E. C. (Univ. of Pittsburgh). J. Chem. Phys.; 57: No. 1, 68-75(1 Jul 1972).

Vacuum ultraviolet multiplets of C I, C II, and O I were produced by electron impact on CO_2. Absolute emission cross sections for these multiplets were measured from threshold to 350 eV. The electrostatically focused electron gun used in this series of experiments is described in detail. The atomic multiplets produced by dissociative excitation of CO_2 and the cross sections at 100 eV are: O I ($2p^4\ {}^3P-2p^33s\ {}^3S$) 1304 Å, 1.04×10^{-18} cm^2 ± 18%; C I ($2s^22p^2\ {}^3P-2s2p^3\ {}^3P^0$) 1329 Å, 2.67×10^{-19} cm^2 ± 21%; C I ($2s^22p^2\ {}^3P-2s2p^3\ {}^3D^0$) 1561 Å, 7.50×10^{-19} cm^2 ± 30%; C I ($2p^2\ {}^3P-2p3s\ {}^3P^0$) 1657 Å, 1.45×10^{-18} cm^2 ± 23%; C II ($2s^22p\ {}^2P^0-2s2p^2\ {}^2D$) 1335 Å, 7.60×10^{-19} cm^2 ± 22%; and C II ($2s2p^2\ {}^2D-2p^3\ {}^2D^0$) 1324 Å, 1.33×10^{-20} cm^2 ± 23%. The dependence of the excitation functions on electron energy shows that these multiplets are produced by electric-dipole-allowed transitions in CO_2. (auth)

39516 IONIC COLLISION PROCESSES IN GASEOUS N_2O. Ryan, K. R. (CSIRO, Sydney). J. Chem. Phys.; 57: No. 1, 271-6(1 Jul 1972).

Ionic collision processes were studied in N_2O by mass-spectrometric techniques with particular emphasis on the state of excitation of the N_2O^+ ion. Evidence is presented for the contention that electrons of energies ≥17 eV on collision with N_2O molecules produce long-lived excited N_2O^+ ions capable of the reactions $N_2O^+ + N_2O \rightarrow NO^+ + N + N_2O$ and $N_2O^+ + N_2O \rightarrow O^+ + N_2 + N_2O$ without significant conversion of translational to internal energy. For electrons with energy ≥17 eV at least 1% of the N_2O^+ ions appear to have internal energy ≥2.4 eV. It is well known that excited N_2O^+ ions are involved in the unimolecular predissociation $N_2O^+ \rightarrow NO^+ + N$. However the abundance of these ions that survive for times appropriate to the collision experiments described here is only about 0.01%. In collision of Ar^+ or N_2^+ with N_2O simple charge transfer predominates over dissociative reactions even though sufficient energy is available for dissociation to occur. (auth)

39517 HETERONUCLEAR ASSOCIATIVE IONIZATION OF ARGON WITH NITROGEN AND CARBON MONOXIDE. Holcombe, Norman T.; Lampe, F. W. (Pennsylvania State Univ., University Park). J. Chem. Phys.; 57: No. 1, 449-54(1 Jul 1972).

Pulsed mass-spectrometric studies of the bimolecular formation of ArN_2^+, $ArCO^+$, and Ar_2^+ in argon–nitrogen mixtures and argon–carbon monoxide mixtures subjected to the impact of 30-eV electrons show that all three reactions proceed with essentially the same specific reaction rate of 1.5×10^{-9} cm^3/s. The effective lifetime of the argon atoms producing ArN_2^+ is longer than that of the argon atoms forming Ar_2^+, but the reverse is true in a comparison of the effective lifetimes for $ArCO^+$ and Ar_2^+ formation. On the basis of the dependence of the ratio ArN_2^+/Ar_2^+ on electron energy and the time delay between electron pulse and ion-drawout pulse, it is concluded that ArN_2^+ has a threshold energy lower than Ar_2^+. The same is probably true of $ArCO^+$ but the effect of delay time in this case is complicated by dissimilar shapes of the pertinent ionization-efficiency curves. It is suggested that Penning ionization of CO becomes progressively more important for the higher-lying states of argon. (auth)

39518 LIFETIME OF CO(a $^3\Pi$) FOLLOWING ELECTRON IMPACT DISSOCIATION OF CO_2. Johnson, Charles E. (Univ. of Calif., Berkeley). J. Chem. Phys.; 57: No. 1, 576-7(1 Jul 1972).

A time-of-flight technique was used to measure the lifetime of metastable CO molecules formed by electron-impact dissociation of CO_2. An average lifetime was obtained from the average slope of the decay plot for each electron-bombardment voltage. The change in average lifetime observed at about 35 eV implies a corresponding change in the relative populations of the CO(a $^3\Pi$) rotational levels. This probably indicates that repulsive states of CO_2 excited above 35 eV produce different relative rotational populations than at lower energies. (A.G.W.)

39519 ROTATIONAL EXCITATION OF A RIGID ROTOR: COMPARISON OF TWO APPROXIMATE CLASSICAL MODELS WITH EXACT CLASSICAL RESULTS. LaBudde, Robert A. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 57: No. 1, 582-3(1 Jul 1972).

The first of two approximate classical models used to calculate rotational excitation of a rigid rotor by an atom was that of a collision of a point particle with a smooth rigid body, whose defining lamina is the zero-energy equipotential of $V(R,\theta)$. The second model was the result obtained from the first-order perturbation of the spherical trajectory, using the action-angle coordinates of Cohen and Marcus (J. Chem. Phys., 49: 4509 (1968)). Results for the system Ar + N_2 are compared with exact classical calculations. It is found that the second model gives qualitatively wrong results, i.e., the odd moments are uniformly of the wrong sign. (A.G.W.)

39520 DISSOCIATION IN HEAVY-PARTICLE COLLISIONS. McClure, G. W.; Peek, J. M. Wiley-Interscience Series in Atomic and Molecular Collisional Processes. New York; John Wiley and Sons, Inc. (1972). 208p. $13.95.

Published information concerned with the dissociation of molecules undergoing single collisions with atoms, ions, or molecules is reviewed critically. A general introduction to the subject of dissociative collisions is followed by five chapters on the experimental approach and one chapter on the theoretical approach used to obtain dissociation data. The experimental portion includes an analysis of experimental methods, an index to experimental data, a list of criteria for evaluation of measurements, and a summary of qualitative findings. The theoretical portion includes discussions of the classical binary and first Born theories and of several subsidiary approximations peculiar to the treatment of dissociative collisions. Tables supply a list of papers devoted to a given collisional system, an identification of the theoretical framework used in each paper, and a list of approximations made in addition to the assumed theoretical framework. (260 references) (A.G.W.)

39521 K-SHELL IONIZATION BY HIGH-ENERGY ELECTRONS. Quarles, C. A. (Texas Christian Univ., Fort Worth). Phys. Lett.; 39A: No. 5, 375-6(5 Jun 1972).

It is shown that the data of Middleman, Ford, and Hofstader on K-shell ionization by electrons with energy from 150 to 900 MeV is fit very well by a relativistic form of Bethe's theory of ionization. (auth)

39522 CHARGE EXCHANGE CROSS SECTIONS MEASURED AT LOW ENERGIES IN Q MACHINES. Andersen, S. A.; Jensen, V. O.; Michelsen, P. (Danish Atomic Energy Commission Research Establishment, Risoe). Rev. Sci. Instrum.; 43: No. 6, 945-7(Jun 1972).

A new technique for measurements of charge exchange cross sections at low energies is described. The measurements are performed in a single-ended Q machine. The resonance charge exchange cross section for Cs at 2 eV was found to be 0.6×10^{-13} $cm^2 \pm 20\%$. (auth)

39523 THRESHOLD ELECTRON IMPACT EXCITATION SPECTRA. IV. TRIATOMIC MOLECULES: N_2O, CO_2, COS, CS_2. Hubin-Franskin, M.-J.; Collin, J. E. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 40: No. 5-8, 361-84(1971).

The electron-impact excitation of N_2O, CO_2, CS_2 and COS was studied by the SF_6 scavenger technique, using a deconvolution method to improve the energy resolution. The spectra are as complex as the uv spectra, and their interpretation is difficult for lack of resolved structure. Most observed transitions correspond to excitation of levels also detected in optical spectra. In addition, a number of structural features are discussed and assigned either to the production of temporary negative molecular ions or to forbidden transitions; N_2O^- ions at 2.2 eV, and COS^- ions at 0.9 eV are observed, as well as forbidden transitions (probably to triplet states) in N_2O at 4.4 eV, in CO_2 at 3.9 and 5.1 eV, in CS_2 at 3.35 and 3.85 eV, and in COS at 4.85 and 8.9 eV. In the energy range above the first ionization limit, many superexcited states are produced; some are either forbidden or preionized, and a correlation with preionized states observed in photoionization studies or in electron-impact ionization is proposed. (auth)

39524 RADIATIVE COLLISIONS. Gudzenko, L. I.; Yakovlenko, S. I. (Lebedev Inst. of Physics, Moscow. Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1686-94 (May 1972). (In Russian).

Elementary acts of excitation transfer by colliding atoms involving simultaneous emission or absorption of the respective quantum are considered. The probability of such acts may be high and may effectively influence the kinetics of atomic-state population in sufficiently strong electromagnetic fields with a frequency close to the resonance frequency. The conditions required for carrying out the relevant experiments are briefly discussed. (auth)

39525 PRODUCTION OF H^- IONS BY CHARGE EXCHANGE OF 1.5 TO 10 keV PROTONS IN THICK VAPOR JETS OF Li, Na, K, AND Mg. D'yachkov, B. A.; Zinenko, V. I.; Pavlii, M. A. (Inst. of Solid State Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1868-71(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2353-6(Nov 1971).

Methods of increasing the intensity of negative hydrogen ion beams are discussed. An analysis of existing data indicates that the most promising method is the production of H^- ions by proton charge exchange in charge-exchange targets with a high conversion coefficient. Charge-exchange targets with low ionization potentials satisfy this condition. The maximum conversion coefficients η_m^- obtained for the targets investigated here are 5.3% for Li, 9.5% for Na, and 4.2% for Mg; for K, the conversion coefficient is 9% at 2 keV and is still increasing as the energy decreases. The optimum thicknesses of the charge-exchange targets are also determined. For the alkali metals, $\delta_{opt} = 2 \times 10^{15}$ atoms/cm^2; $\delta_{opt} = 3 \times 10^{15}$ atoms/cm^2 for Mg. (auth)

Atomic Theory

Refer also to abstracts 39173 and 40188.

39526 EFFECTIVENESS OF SYMMETRY AND THE PAULI CONDITION ON THE 1 MATRIX IN THE REDUCED-DENSITY-MATRIX VARIATIONAL PRINCIPLE. Kijewski, L. J. (Monmouth Coll., West Long Branch, N. J.). Phys. Rev., A; 6: No. 1, 31-5(Jul 1972).

Application is made of the reduced-density-matrix variational principle using a pair matrix constructed of geminals obtained from 1s, 2s, and 2p orbitals. The objective is to test the strength of the Pauli restriction on the 1 matrix and certain symmetry conditions for improving the lower bound to the ground-state energy. With the particular trial pair matrix used, the Pauli restriction on the 1 matrix improves the percentage error in the energy lower bound for C^{++} by a factor of approximately 6. (auth)

39527 VANISHING OF DIPOLE MATRIX ELEMENTS AT LEVEL CROSSINGS. Kocher, Carl A. (Columbia Univ., New York). Phys. Rev., A; 6: No. 1, 35-7(Jul 1972).

The vanishing of certain coupling matrix elements at level crossings is shown to follow from angular momentum commutation relations. A magnetic dipole transition having $\Delta M = \pm 1$, induced near a crossing of the levels in a nonzero magnetic field, is found to have a dipole matrix element comparable to or smaller than the quotient of the level separation and the field. This result also applies in the analogous electric field electric dipole case. (auth)

39528 EXPERIMENTAL LIMITATIONS TO THE VALIDITY OF SEMICLASSICAL RADIATION THEORIES. Clauser, John F. (Univ. of California, Berkeley). Phys. Rev., A; 6: No. 1, 49-54 (Jul 1972).

The polarization correlation of photons emitted in an atomic cascade is treated in the framework of a general semiclassical radiation theory. The resulting predictions are contrasted with those of orthodox quantum-radiation theory. Experimental evidence is discussed, which is in agreement with the latter theory but excludes semiclassical theories in general. (auth)

39529 RENORMALIZED FREQUENCY SHIFT OF COHERENT RADIATION. Lee, Y. C.; Lin, D. L. (State Univ. of New York, Buffalo). Phys. Rev., A; 6: No. 1, 388-92(Jul 1972).

The radiative correction to the frequency of the spontaneous radiation from a system of two-level atoms in correlated states is calculated in the resonance approximation. A general prescription for renormalization without explicit reference to plane-wave states is given and used to obtain the renormalized frequency shifts. It is shown that the coherence frequency shift is not affected by the mass renormalization. (auth)

39530 LENGTH AND VELOCITY FORMULAS IN APPROXIMATE OSCILLATOR STRENGTH CALCULATIONS. Cohen, M. (Hebrew Univ., Jerusalem)· McEachran, R. P. Chem. Phys. Lett.; 14: No. 2, 201-4(15 May 1972).

The matrix element for electric dipole transitions is given correctly neither by the length formula nor by the velocity formula in the frozen core Hartree–Fock approximation, contrary to the assertion of Starace. (auth)

39531 USE OF EXPLICITLY CORRELATED, PARTIALLY ANTISYMMETRIC WAVE FUNCTIONS IN ATOMIC AND MOLECULAR CALCULATIONS. Simons, Jack (Massachusetts Inst. of Tech., Cambridge). Int. J. Quant. Chem.; 6: No. 3, 439-48 (May 1972).

Trial wave functions, written as the sum of a configuration-interaction expansion and an explicitly correlated term that is not antisymmetric, are proposed for use in calculating the electronic properties of atoms and molecules. A variational principle, modified to allow the use for such partially antisymmetric wave functions, is developed. It is shown that the consequences of partial antisymmetry on calculated expectation values can be estimated. The method avoids difficult three-electron integrals that arise in other theories. (auth)

39532 GENERAL SCHEME OF USING NONORTHOGONAL RADIAL ORBITALS IN A COMPLEX ELECTRONIC CONFIGURATION OF THE ATOM. Jucys, A. P.; Grudzinskas, J. J. (Inst. of Physics and Mathematics, Vilnyus, USSR). Int. J. Quant. Chem.; 6: No. 3, 455-64(May 1972).

A theory for using nonorthogonal radial orbitals between shells with identical orbital quantum numbers, in the case of complex configurations, is presented. Construction of the antisymmetric wave function of the whole configuration, with the help of antisymmetrical wave functions of individual shells, is described. General methods of calculating matrix elements of one- and two-electron operators are given. (auth)

39533 GENERAL THEORY OF THE EXTENDED METHOD OF CALCULATION OF ATOMIC STRUCTURES. Jucys, A. P.; Naslenas, E. P.; Zvirblis, P. S. (Inst. of Physics and Mathematics, Vilnyus, USSR). Int. J. Quant. Chem.; 6: No. 3, 465-72(May 1972).

A general theory of the extended method of calculation of atomic structures having complex configurations is presented. It is based on the correspondence between the radial integrals of the ordinary method and the linear combinations of those of the extended method. The rules for going over from the ordinary method to the extended one are given. (auth)

39534 GAUSSIAN REPRESENTATIONS OF CHARGE OVERLAP EFFECTS IN INTERMOLECULAR FORCES. Riera, A.; Meath, W. J. (Univ. of Western Ontario, London). Int. J. Quant. Chem.; 6: No. 3, 501-8(May 1972).

The ground state $H-H^+$ and $H-H$ interactions are used as model interactions for investigating the feasibility of using Gaussian basis sets for representing charge overlap effects in intermolecular forces. The nonexpanded charge-induced dipole energy and the nonexpanded dipole—dipole dispersion energy, respectively, for these interactions are calculated using two types of Gaussian basis functions to represent the first-order wave function, $\psi^{(1)}$. Very good results for these interaction energies, which include charge overlap effects, are obtained for all interatomic separations by using small Gaussian basis sets to represent the interaction, that is $\psi^{(1)}$, and/or the isolated atoms (the zeroth-order wave function). (auth)

39535 NEW PROOF OF THE MINIMUM PRINCIPLE FOR EXCITED STATES. Young, Ralph H. (Univ. of California, Riverside). Int. J. Quant. Chem.; 6: No. 3, 596-7(May 1972).

A proof of the principle that, if H is a self-adjoint operator in Hilbert space, the nth root of a linear variational computation for H is an upper bound to the nth eigenvalue of H is presented briefly. (A.G.W.)

39536 TEST OF THE MANY-ELECTRON THEORY OF ATOMS IN AN EXACTLY SOLVABLE MODEL. Calles, A. (Univ. de Mexico, Mexico City); Moshinsky, M.; Novaro, O.; Sinanoglu, O. Phys. Lett.; 40A: No. 1, 79-80(19 Jun 1972).

The many-electron theory of ground states of Sinanoğlu is tested on an exactly solvable model. The many-electron-theory wave functions and energies reproduce closely the exact solutions. (auth)

39537 RECENT THEORETICAL INVESTIGATIONS ON SINGLY AND DOUBLY EXCITED STATES OF TWO-ELECTRON ATOMIC SYSTEMS. Midtdal, J. (Univ. of Oslo); Aashamar, K.; Holoeien, E.; Lyslo, G. Phys. Norv.; 5: No. 3-4, 177-97(1971).

A survey is given of recent applications of the Hylleraas—Scherr—Knight procedure and the multiconfiguration energy-bound method, respectively, to excited states of atomic systems. The two methods are briefly described, and a summary of the best results furnished by these procedures for the energy of various excited states of two-electron atoms and ions is presented. The states $1s2s\,^3S$ and $1s3s\,^3S$ are treated in more detail, and a few preliminary results of some high-precision calculations now in progress are reported. A comparison is made between results obtained with different types of basis functions. Finally, the most recent development concerning the wavelength of the $(2p)^2\,^3P-1s2p\,^3P$ transition in ^{4}He I is reviewed. The latest experimental result is in excellent agreement with the theoretical value. (auth)

39538 VARIATIONAL PERTURBATION THEORY CALCULATIONS OF THE NON-RELATIVISTIC ENERGY OF THE STATE $2p3p\,^3P$. Midtdal, J.; Braaten, K.-A. (Univ. of Oslo). Phys. Norv.; 5: No. 2, 103-9(1971).

The variational perturbation procedure was applied to the doubly excited two-electron state $2p3p\,^3P$. The calculations were carried through to 20th-order wave functions with 113-term expansions of the standard Hylleraas type. Estimates of the perturbation energy coefficients through 21st order are tabulated, and the nonrelativistic energies are given for some of the first elements of the isoelectronic sequence. The state $2p3p\,^3P$ is the second one of the given symmetry. Orthogonality to the lower-lying state $2p^2\,^3P$ was secured by including its zeroth-order function. Hence, the energies obtained are upper bounds to the corresponding exact energies according to the upper-bound theorem. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

39539 MAGNETOHYDRODYNAMIC FLOWS IN A PULSATING MAGNETIC FIELD BY THE METHOD OF CHARACTERISTICS. But, D. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 6, 3-9(Nov-Dec 1971). (In Russian).

For investigating MHD arrangements with a magnetic Reynolds number (R_m) ~ 1, transitional process problems arise in connection with a pulsating magnetic field. For their solution, the method of characteristics was applied. By introducing some allowable boundaries, it is possible to construct a model of quasi-one-dimensional nonsteady MHD flows with hyperbolic quasi-linear systems of first-order equations, for which Kosha data are successfully formulated on a limiting curve or a three-dimensional or characteristic type. Two types of problems of a similar nature are solved for conducting currents in a pulsating, transverse, magnetic field. The first type embraces supersonic gas flows in ducts. The second relates to the motion of a free jet of an incompressible fluid. (K.S.W.)

39540 THEORETICAL STUDY OF THE MAGNETOGASDYNAMIC INSULATOR BOUNDARY LAYER. Matthias, Charles Stanley. Toronto; Univ. of Toronto (1970). National Library of Canada, Ottawa.

Thesis.

A system of magnetogasdynamic (MGD) multifluid equations for a seeded plasma describes the insulator boundary layer properties in an MGD duct. The duct is chosen to operate as a constant-area, segmented-electrode Faraday generator. Effects described by the equations include fluid cross flow caused by an axial Hall component of current in the boundary layer, an electron temperature T_e which differs in general from the atom temperature T, ambipolar diffusion and chemical nonequilibrium adjacent to the cool neutralizing wall, and the depression of the electron number density if the plasma is not in local thermodynamic equilibrium (LTE). Numerical calculations were made for several flow conditions, each differing by a single parameter change from a standard case describing a subsonic, atmospheric plasma with an atom temperature at 2000°K, magnetic field strength of 1 weber/m^2, loading factor of .5, and seeding ratio of .001. The effect of line radiation loss is examined numerically in some free-stream calculations. The results predict a plasma breakdown electric field that must be overcome if elevated conductivity operation is to be achieved. The relaxation time for ionization in the free stream is shown to increase enormously if both resonance radiation loss and non-LTE, caused by higher line radiation loss, are considered. (Diss. Abstr. Int., B)

39541 INFLUENCE OF AMBIPOLAR DIFFUSION ON THE ELECTRICAL CONDUCTIVITY IN A MHD GENERATOR. Holzapfel, Chr. (Kernforschungsanlage, Juelich, Ger.). Plasma Phys.; 13: No. 12, 1117-21(Dec 1971).

Theoretical and experimental investigations in MHD energy conversion have shown that there are several processes in the working plasma of a MHD generator which reduce the electrical conductivity and thus also reduce the total efficiency of the generator system. Because the plasma is bounded two important processes reduce the electrical conductivity, the radiation of the plasma and the diffusion of electrons out of the discharge region. The influence of radiation losses on the electrical conductivity has been described by many authors but only a few consider influence of the diffusion processes. A short outline of the theory of ambipolar diffusion is given and the region of temperature and geometry where one must consider this phenomenon is shown. (auth)

39542 SUPERCRITICAL STATIONARY STATES OF HYDROMAGNETIC COUETTE FLOW. Chang, T. S. (Cornell Univ., Ithaca, N. Y); Sartory, W. K. Plasma Phys.; 13: No. 12, 1123-39 (Dec 1971).

The nonlinear behavior of hydromagnetic Couette flow beyond the critical point is studied using the "discrete Fourier transforms". Quasilinear and higher order nonlinear results for the torque ratio are presented for the case of a stationary outer cylinder. The axial distribution of the total shear at the inner cylinder is also described. Only axially symmetric disturbances and supercritical stationary states were considered. (auth)

39543 POTENTIAL EQUATIONS IN FLUID MAGNETODYNAMICS. Casal, Pierre (Univ., Marseille). Compt. Rend., Ser. A; 274: No. 9, 806-8(28 Feb 1972). (In French).

A system of equations for expressing the velocity and the magnetic field in terms of six scalar potentials is presented. The system explains the evolution of these potentials. Some particular cases are considered: potential equations for compressible fluids for which the scalar product (1/rho)rot V.grad s is constant along the trajectories. (France)

39544 HEAT TRANSFER IN MHD CHANNEL FLOW BETWEEN CONDUCTING WALLS. Soundalgekar, V. M. (Indian Inst. of Tech., Bombay). Rev. Roum. Phys.; 17: No. 3, 313-25(1972).

An analysis of convective heat transfer in fully-developed MHD channel flow between two parallel electrically conducting plates was carried out. Closed-form solutions for temperature are derived in terms of the total current I, wall conductance ratio m, thermal conductance ratio ψ, the Hartman number M, heat flux Q, and the modified Pe'clet number S. The effects of these parameters on the heat transfer were discussed. It is observed that an increase in ψ leads to an increase in the temperature. (auth)

39545 SUPERPOSABILITY IN MAGNETOGASDYNAMICS. Colwell, D. J. (North Staffordshire Polytechnic, Stafford, Eng.). Acta Phys. Austr.; 34: No. 4, 331-6(1971).

Superposable flows in magnetogasdynamics are defined, and the conditions for superposability and self-superposability are obtained. After considering the equations involving entropy it is shown that physically realistic flows may be expected in a self-superposed flow. By expressing the velocity and magnetic field strength in terms of four scalars, which are azimuth-independent, the conditions for self-superposability in the axisymmetric case are then deduced, and some particular solutions of them are investigated. (auth)

39546 NEGATIVE TEMPERATURES IN TWO-DIMENSIONAL VORTEX MOTION. Taylor, J. B. (Culham Lab., Abingdon, Eng.). Phys. Lett.; 40A: No. 1, 1-2(19 Jun 1972).

The critical energy for the onset of negative temperatures in vortex calculations is determined, and the identity of this threshold with other bounds on the initial conditions is noted. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 39785.

39547 DIFFERENTIAL CROSS-SECTION FOR SCATTERING OF A NON-PARALLEL NON-UNIFORM BEAM IN A TARGET OF FINITE SIZE AND ABSORPTION. Harigovindan, S. (Univ. of Kerala, Trivandrum, India). Nucl. Instrum. Methods; 102: No. 1, 117-20(1972).

Two methods of determining the differential cross-section taking into account the effects produced by a non-uniform and nonparallel beam and finite dimensions and absorption of the target, are described, one requiring complete beam data, and the other using only scattering data. Their relative merits are discussed regarding statistical errors showing that the detector geometry plays a crucial role. (auth)

Electromagnetic

Refer also to abstract 39619.

39548 (DESY–72/18) ELECTROMAGNETIC FORM FACTORS OF THE NEUTRON AT SQUARED FOUR-MOMENTUM TRANSFERS OF 1.0 AND 1.5 $(\mathrm{GeV}/c)^2$. Bartel, W.; Buesser, F.-W.; Dix, W.-R.; Felst, R.; Harms, D.; Krehbiel, H.; Kuhlmann, P. E.; McElroy, J.; Meyer, J.; Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1972. 14p. Dep. NTIS (U. S. Sales Only).

Quasielastic electron–deuteron cross sections were measured at squared four-momentum transfers of 1.00 and 1.53 $(\mathrm{GeV}/c)^2$ and electron-scattering angles of 12 and 86°. Both electron-neutron and electron-proton coincidences were recorded and the electromagnetic neutron form factors G_E^N and G_M^N were determined by the ratio method. The elastic e-p-scattering cross section derived from the quasielastic scattering cross sections agrees with the known cross section for electron scattering on a free proton. (auth)

39549 (JINR–P4-6356) QUANTUM-MECHANICAL PROBABILITY OF THE MICROPARTICLE SPIN $\hbar/2$ ROTATION IN THE ARBITRARILY VARIED MAGNETIC FIELD. Matora, I. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

A quantum-mechanical equation is solved for the spin wave functions of nonrelativistic microparticles with spin $\hbar/2$ in the arbitrarily varied magnetic field $\bar{H}$ in a mobile coordinate system of which the axis oz is always directed along the total vector $\bar{H}$ while rotation has an angular velocity of the rotation of vector $\bar{H}$. It is shown, in particular, that focused neutrons can move in the field of the ring accumulator with the sixpole magnet during the lifetime of a neutron without noticeable loss due to the spin rotation. (auth)

39550 (LNF–71/93) ANALYSES OF MEASUREMENT OF THE COLLISION CROSS SECTION FOR SINGLE PHOTOPRODUCTION. PART IIa. π^0 FROM THRESHOLD TO 500 MeV. Spillantini, P.; Valente, V. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 20 Dec 1971. 29p. (In Italian). Dep. NTIS (U. S. Sales Only).

The results on the analysis of the measurement of the collision cross section of π^0 are tabulated. The method and procedure are analogous to those used for π^+ aside from the obvious modification of the analytical expression of the angular distributions. All the details of the analysis are given. (J.S.R.)

39551 (SLAC–146) PARTICLE PHYSICS WITH POSITRON–ELECTRON–PROTON COLLIDING BEAMS. (Stanford Linear Accelerator Center, Calif. California Univ., Berkeley. Lawrence Berkeley Lab.). Apr 1972. Contract AT(04-3)-515. 58p. (LBL–750). Dep. NTIS.

The various interactions which can be studied using a proposed positron–electron–proton colliding beam complex (PEP) are discussed in detail. The proposed experiments are on e^- (e^+) + p → e^- (e^+) + anything interactions studying the scattered lepton and the nature of the hadronic states in the anything, weak interactions in e + p → ν + anything, photoproduction where the scattered electron produced a spectrum of essentially real photons for the study of γ + p reactions, and e^- + e^+ interactions in colliding beams. It is found that PEP is capable of an enormous extension of parameters in traditional experiments and will open the field of weak interactions to practical experimentation with the well understood electron. The energies of the beams in PEP are chosen to be about 15 GeV for electrons and positrons and 72 GeV for protons giving a cms energy for electron–proton reactions of 65 GeV, which is the same as that which would be available is a 2000-GeV beam from a conventional accelerator strikes a stationary hydrogen target. (J.F.P.)

39552 STRONG-CUT REGGEIZED ABSORPTION MODEL AND THE REACTION $\gamma + p \rightarrow K^+ + \Sigma^0$. Scherkoske, Kenneth David. Toledo; Univ. of Toledo (1971). 118p. University Microfilms Order No. 72-16,257.

Thesis.

It was the purpose of this research to test the so-called strong-cut Reggeized absorption model for the scattering of those elementary particles that interact by means of the strong nuclear force by comparing the predictions of the model with the experimental differential cross section for the photoproduction process $\gamma + p \rightarrow K^+ + \Sigma^0$. (TSS) (Diss. Abstr. Int., B)

39553 PRECISION MEASUREMENT OF THE MAGNETIC MOMENT OF THE MUON. Crowe, K. M. (Univ. of California, Berkeley); Hague, J. F.; Rothberg, J. E.; (and others). Phys. Rev., D; 5: No. 9, 2145-61(1 May 1972).

A determination of the ratio of the muon to the proton magnetic moment, μ_μ/μ_p, is described. The precession rate of positive muons was compared to that of protons in the same magnetic field and chemical environment. Attention is given to the points which bear on the accuracy of the result: timing, magnetic field, many systematic checks, and particularly the question of the chemical environment of the μ^+. It is shown experimentally that the so-called "Ruderman correction"—the ionic state in water once tentatively proposed by Ruderman—does not occur. A physical effect which excludes the possibility of the ionic state is pointed out. Consistent results were obtained in three different media: water, NaOH solution, and an organic liquid. Chemical corrections were ≤2 ppm. The result, including residual uncertainties in the chemical corrections, is $\mu_\mu/\mu_p = 3.1833467 \pm 0.0000082$ (2.6 ppm); in terms of the muon mass this implies m_μ $m_e = 206.7682 \pm 0.0005$, or $m_\mu = 105.6594 \pm 0.0004$ MeV. The new value for the muon moment, used with the most recent measurements of the muonium hyperfine interval, yields a value for the fine-structure constant of $\alpha^{-1} = 137.03632 \pm 0.00019$, an accuracy comparable with that of the current recommended value which depends primarily on the Josephson effect. The two numbers differ by 2.2 ppm, while the standard deviation of the difference is 2.1 ppm, which is satisfactory agreement. (auth)

39554 INVESTIGATION OF THE VERTICES $\pi^0\gamma\gamma$, $\eta\gamma\gamma$, AND $\eta'\gamma\gamma$ WITH ELECTRON–POSITRON STORAGE RINGS. II. Parisi, J. (Univ., Paris); Kessler, P. (Phys. Rev., D; 5: No. 9, 2237-45(1 May 1972).

An experimental investigation of the $X\gamma\gamma$ vertices ($X = \pi^0$, η, or η') is suggested in the specific case where both photons are spacelike, one of them being almost real and the other one highly virtual. For this purpose, it is suggested that, in an electron-positron storage ring, e^-e^+ inelastic collisions of the type $e^-e^+ \rightarrow e^-e^+X \rightarrow e^-e^+\gamma\gamma$ should be analyzed, one of the outgoing $e^\pm$ particles being detected at a very small scattering angle (a few milliradians), in coincidence with the other one measured at a relatively large scattering angle (higher than a few degrees) and with both decay photons emitted at large angle with respect to the beam axis. Assuming various experimental cutoffs on angles and energies, it is shown that (a) the background due to double bremsstrahlung can be made negligible through our choice of these cutoffs; (b) for $X = \pi^0$ or η, the cross sections should be high enough to justify experiments of this type to be planned with future storage rings of beam energy ≳3 GeV and luminosity $\gtrsim 10^{32}$ cm^{-2} sec^{-1}; (c) such experiments should allow a discrimination between various types of electromagnetic form factors used for the $X\gamma\gamma$ vertices. (auth)

39555 MEASUREMENT OF π^-/π^+ RATIOS IN PHOTOPRODUCTION FROM DEUTERIUM: THE DIP TEST OF AN ISOTENSOR CURRENT. Fujii, T. (Tokyo Univ.); Homma, S.; Kato, S.; (and others). Phys. Rev. Lett.; 28: No. 25, 1672-5(19 Jun 1972).

The angular distributions of π^-/π^+ ratios in photoproduction from deuterium were measured for fourteen photon energies between 260 and 800 MeV. The energy dependence of $\sigma^- - \sigma^+$ near the $\Delta_{33}(1236)$ resonance region shows no dip structure, consistent with an absence of the isotensor term. The differential cross sections of $\gamma n \rightarrow n^-p$ at k = 350 MeV are considerably larger than the ones obtained from the inverse reaction $\pi^-p \rightarrow \gamma n$, but the two are in fair agreement at k = 500 MeV. (auth)

39556 INTERACTION OF 76-GeV PROTONS WITH NUCLEAR EMULSIONS. Takibaev, Zh. S.; Boos, E. G.; Rus'kina, G. Ya. (Inst. of High Energy Physics, Alma-Ata, USSR). Dokl. Akad. Nauk SSSR; 200: No. 5, 1074-6(11 Oct 1971). (In Russian).

The number of "black", "grey", and "thin" traces in emulsion were compared for 76 GeV protons, and correlations were obtained between black and grey traces. A hydrodynamic mechanism apparently characterizes particles of this energy. A nucleon-nucleus interaction exhibited a dependence upon the primary proton energy. (K.S.W.)

39557 PHOTOPRODUCTION OF K^0 MESONS FROM ALUMINUM NUCLEI. Asatiani, T. L.; Zhirova, L. A.; Ivanov, V. A.; Krishchyan, V. M.; Nagorskaya, I. A. (Erevan Inst. of Physics). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1614-20(May 1972). (In Russian).

Results are presented of an investigation of K^0_2-meson production from aluminium nuclei at 10° to γ-beams with maximum energies of 4 and 4.7 GeV. The cross sections for K^0_2-meson production in the momentum range $0.95\ \text{GeV/c} < p_K \leq p_K{}^{max}$ are 11.0 ± 1.54 and 21.1 ± 1.96 μb/sterad · eq · γ respectively. An estimation of the upper limit of the cross section for the reaction $\gamma + p \rightarrow K^0 + \Sigma^+$ yields for the same energies 1.86 ± 1.07 and 1.51 ± 1.06 μb/sterad. (auth)

Weak

Refer also to abstracts 38522 and 38528.

39558 (PCCF-PUB-71/6) INELASTIC INTERACTION INDUCED BY HIGH ENERGY MUONS (6 GeV, 12 GeV) AT LOW MOMENTUM TRANSFER IN NUCLEAR EMULSION. Montret, J. C.; Coupat, B.; Michel, B.; Vazeille, F. (Clermont-Ferrand Univ. (France). Laboratoire de Physique Corpusculaire). 8 Oct 1971. 14p. Dep. NTIS (U. S. Sales Only).

The inelastic scattering of 6- and 12-GeV muons was studied in Ilford K5 nuclear emulsions. For energy transfers greater than 150 MeV (for π's muoproduction threshold) and a four momentum transfer smaller than 0.1 $(\text{GeV/c})^2$, the cross sections are respectively 11.1 ± 1.4 μb/nucleon at 12 GeV and 6.8 ± 0.9 μb/nucleon at 6 GeV. The ratio of mean values of longitudinal to transverse cross section are respectively 0.46 ± 0.15 and 0.25 ± 0.15. These values are very useful for a comparison between electron and muon. (auth)

39559 (PCCF-PUB-71/8) HIGH ENERGY MUOPRODUCTION AND VECTOR DOMINANCE MODEL. Michel, B.; Montret, J. C. (Clermont-Ferrand Univ. (France). Laboratoire de Physique Corpusculaire). 25 Oct 1971. 12p. Dep. NTIS (U. S. Sales Only).

Muon-nucleon inelastic scattering at high energy and low momentum transfer, induced by 6 GeV and 12 GeV incoming muons in nuclear emulsions, was studied. The experimental cross sections are analyzed by means of the vector dominance model. A comparison was also established between the values of the cross section and similar measurements of Dieterle and al. A theoretical fit of these results was finally realized using the rho dominance model. (auth)

39560 (PCCF-RI-71/8) HIGH ENERGIES MUOPRODUCTION (6 GeV, 12 GeV) AND LOW MOMENTUM TRANSFER. Montret, J. C.; Coupat, B.; Michel, B.; Vazeille, F. (Clermont-Ferrand Univ. (France). Laboratoire de Physique Corpusculaire). 1 Jun 1971. 4p. Dep. NTIS (U. S. Sales Only).

K5 Ilford nuclear emulsions irradiated with the muon beam of the Stanford Linear Accelerator Center were analyzed. The total at differential muoproduction cross sections at 6 GeV and 12 GeV energies were determined. (auth)

39561 (SLAC-145) MEASUREMENT OF THE DECAY $K^0_L \rightarrow \pi^0\pi^0$. Akavia, G.; Coombes, R.; Dorfan, D.; (and others) (Stanford Linear Accelerator Center, Calif. Stanford Univ., Calif. Dept. of Physics). Apr 1972. Contract AT-(04-3)-515. 30p. Dep. NTIS.

A measurement of the rate $\Gamma(K^0_L \rightarrow 2\pi^0)$ was made relative to the rates $\Gamma(K^0_L \rightarrow 3\pi^0)$, $\Gamma(K^0_L \rightarrow \pi^\pm\mu^\pm\nu_\mu)$ and $\Gamma(K^0_L \rightarrow \pi^\pm e^\pm \nu_e)$ in a spark chamber scintillation counter experiment. Using published branching rates of the three body decays relative to the rate $\Gamma(K^0_L \rightarrow \text{all})$ and the rate $\Gamma(K^0_s \rightarrow 2\pi^0)$ $\Gamma(K^0_L \rightarrow 2\pi^0)/\Gamma(K_L \rightarrow 3\pi^0) = 3.2 \pm 2.5 \times 10^{-3}$ and the CP violation parameter $|\eta_{00}|^2 = 3.6 \pm 2.9 \times 10^{-6}$ are found. This is in agreement with the previous average for $|\eta_{00}|$. (auth)

39562 CONSERVATION OF LEPTON CHARGE DURING β DECAY. Borovoi, A. A.; Plis, Yu. A.; Khodel, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Probl. Fiz. Elem. Chastits At. Yadra; 2: No. 3, 691-716(1972). (In Russian).

The review of recent data concerning lepton charge conservation in the beta decay processes was made. The experiments on the search for the neutrinoless double beta decay and the evaluations of the nuclear matrix elements are discussed. The experiments on the search for the reciprocal beta decay with lepton nonconservation are viewed. Estimates of the upper limit of the lepton nonconservation parameter, received from the different experiments, are given. (auth)

Strong (Baryon-induced)

Refer also to abstracts 39102 and 39666.

39563 (JINR-P1-6308) STUDY OF THE SPECTRA OF FAST DEUTERONS PRODUCED IN THE INTERACTION OF 670 MeV PROTONS WITH NUCLEI. Azhgirei, L. S.; Dal'karov, O. D.; Krumshtein, Z. V.; Merekov, Yu. P.; Moroz, Z.; Ngo Kuang Zui; Petrukhin, V. I.; Ronzhin, A. I.; Shelkov, G. A.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 31p. (In Russian). Dep. NTIS (U. S. Sales Only).

Deuteron spectra were determined in the momentum range 700 to 1,700 MeV/c while being emitted at the angles 6.5, 9.5, 13.5 and 16° as a result of the interaction of protons with the nuclei H, D, ^{6}Li, ^{7}Li, C, Al, Cu, Rh, and Pb. The differential cross sections of deuterons from nuclei were measured for the reactions $p\langle 2N\rangle \rightarrow dM$ and $p\langle N\rangle \rightarrow d_\pi$ for the nuclei and angles selected. The results obtained are discussed relative to the dispersion theory of direct reactions. (tr-auth)

39564 OBSERVATION OF RHO-OMEGA INTERFERENCE IN $\bar{p}p$ ANNIHILATION AT 2.32 GeV/c. Rhines, Don Scott. Columbus, Ohio; Ohio State Univ. (1971). 167p. University Microfilms Order No. 72-15,279.

Thesis.

Evidence of $\rho^0-\omega$ interference observed in the $\pi^+\pi^-$ mass spectrum from the reaction $\bar{p}p \rightarrow 2\pi^+2\pi^-$ occurring at an incident momentum of 2.32 GeV/c is presented. The data were obtained from exposures of the MURA 30″ hydrogen bubble chamber at the Argonne National Laboratory ZGS. To aid in the analysis, the general properties of the 4π final state and of the $\omega^0\pi^+\pi^-$ final state in 5π are studied. Fitting the $\rho^0-\omega$ interference effect indicates the effect has a statistical significance of greater than four standard deviations, and gives limits on the branching ratio $R(\omega^0 \rightarrow \pi^+\pi^-/\omega^0 \rightarrow \pi^+\pi^-\pi^0)$ of $0.003 \leq R < 0.32$ (95% confidence level). Further, this result gives evidence of high coherence between the ρ and ω amplitudes. Study of other data available in the incident momentum range from 0.77 to 2.32 GeV/c shows all the data to be consistent with the same magnitude and same phase difference between the ρ and ω amplitudes. (Diss. Abstr. Int., B)

39565 p-d ELASTIC CROSS SECTION AND POLARIZATION AT 198 MeV. Adelberger, R. E.; Brown, C. N. (Univ. of Rochester, N. Y.). Phys. Rev., D; 5: No. 9, 2139-42(1 May 1972).

p-d elastic cross-section and polarization measurements are presented at an incident energy of 198 MeV, over the center-of-mass angular range 80° to 170°. The peak in the backward or pickup region is examined in terms of a simple nucleon-exchange parametrization. (auth)

39566 INTERACTIONS BETWEEN NUCLEI AT 100 TO 500 MeV/NUCLEON. Resman, R.; Otterlund, I. (Lund Univ., Sweden). Phys. Scr.; 4: No. 4-5, 183-9(1971).

Nucleus-nucleus interactions produced by heavy cosmic ray primaries in nuclear emulsions were analyzed. The kinetic energy of the incident nuclei is 100 to 500 MeV/nucleon. Whenever possible the particles leaving the point of interaction were identified and their emission angles and kinetic energies measured. The angular and energy distribution of the protons emitted can be understood if reasonable values of the momenta of the interacting nucleons inside the colliding nuclei are considered, and if it is further assumed that interactions between nucleons and clusters of nucleons occur. The momentum distribution of the emitted protons and alpha particles is consistent with an average recoil momentum of the target nuclei of about 23 MeV/c per nucleon. It is found that about 30% of the particle with ranges in the interval $10\ \mu m < R < 100\ \mu m$ cannot be explained by ordinary evaporation theory. The spallation of the target and the projectile was studied. It was found that the disintegration of the two interacting nuclei increases with increasing projectile energy. (auth) (Sweden)

39567 PION MULTIPLICITIES FROM PROTON-ANTIPROTON ANNIHILATION. Jasselette, P.; Vandermeulen, J. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 40: No. 5-8, 241-9(1971).

The experimental results for the cross sections of $p\bar{p}$ annihilation into pions at 7 GeV/c are examined. The coefficients which relate the different charge substates of each multiplicity are calculated in several assumptions, and it is shown that the production of uncorrelated pion production contradicts the observed distribution of charges. The major failure is associated with even pion multiplicities; a parametrization of pion production in terms of isovector pion pairs seems to correct for the main part of the discrepancy. An estimation of the pion number distribution is obtained whose main feature is to be much narrower than a Poisson distribution. (auth)

39568 NUCLEAR PHYSICS WITH MESONS. Bressani, Tullio (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Mem. Accad. Sci. Torino, Cl. Sci. Fis. Mat. Natur. (4); No. 13, 1-21(1971). (In Italian).

The most recent results on the excitation of the analog states of dipole giant resonances by means of capture of μ^- and π^- at rest by nuclei whose ground states have the quantum spin and parity numbers of $J^\pi = 0^+$ were reported and discussed. The future prospects regarding the study of the excited states of hypernuclei by means of K^- in flight were then discussed. (auth)

Strong (Meson-induced)

Refer also to abstract 38531.

39569 (CERN-Trans-71-41) INVESTIGATION OF REACTIONS AT A MOMENTUM OF 2.94 GeV/c. Barmin, V. V.; Golubchikov, V. M.; Davidenko, G. V.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by B. Hodge (CERN, Geneva, Switzerland), from report ITEF-886. 14p. Dep. NTIS (U. S. Sales Only).

The systems of π^0-mesons and γ-quanta were studied in $\pi^- + p \rightarrow \eta + m\gamma$ reactions at π^--meson momenta of 2.94 GeV/c. In the effective mass distributions of the $\pi^0\gamma$ and $2\pi^0$ systems, maxima are observed which correspond to the production of ω and f mesons. In the $2\pi^0$ system a large excess of events is found above the phase shift curve at a mass of ~700 MeV and at a width of ~300 MeV. The values of the elements of the spin matrix of density ρ_{00}, ρ_{1-1}, and Re ρ_{10} are obtained for the ω-meson in the $\omega \rightarrow \pi^0 + \gamma$ decay. The distributions of the squared 4-momentum transfer and the angular distributions for various parts of the spectrum of the $\pi^0\gamma$ and $2\pi^0$ systems were obtained. The cross sections of $\pi^- + p \rightarrow \eta + m\gamma$ reactions at m = 3, 4, 6, 8, 10 and of certain other reactions involving π^0-meson and γ-quanta production are given. (auth)

39570 (CERN-Trans-71-43) STUDY OF THE REACTION $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ AT AN INITIAL π^--MESON MOMENTUM OF 40 GeV. Proposed Experiment. Barkov, B. P.; Vladimirskii, V. V.; Katinov, Yu. V.; Sutormin, A. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by R. Luther (CERN, Geneva, Switzerland), from report ITEF-859. 20p. Dep. NTIS (U. S. Sales Only).

A proposed experiment is described for the measurement of the dependence of the differential cross sections on the four-momentum in the reaction $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ at 40 GeV/c. The four-momentum range is 0.04 to 0.40 $(GeV/c)^2$, and the value of the invariant mass M_0 in the $\pi^+\pi^-$ system is $0.28 < M_0 < 3.0$ GeV/c^2. The kinematic possibilities of the detector and estimates of possible values for the effect and contribution of background reactions, accuracies, and possibilities for data acquisition are discussed. (J.F.P.)

39571 (CERN-Trans-71-46) STUDY OF THE REACTION $\pi^- + p \rightarrow n + 6\gamma$ at 2.94 GeV/c. Novikov, L. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by M. Wolleb (CERN, Geneva, Switzerland), from report ITEF-887. 6p. (In French). Dep. NTIS (U. S. Sales Only).

The $3\pi^0$ and $2\pi^0\eta$, $\eta \rightarrow 2\gamma$ systems are studied in the reaction $\pi^- + p \rightarrow n + 6\gamma$ at a π^- momentum of 2.94 GeV/c. The excess of events above the calculated curves is due to the reactions $\pi^- + p \rightarrow n + \eta$, $\eta \rightarrow 3\pi^0$ and $\pi^- + p \rightarrow n + \eta^1$, $\eta^1 \rightarrow 2\gamma$. The cross sections for these reactions are evaluated. (tr-auth)

39572 (COO-1112-27) LARGE ANGLE DIFFERENTIAL CROSS SECTION FOR K^+p ELASTIC SCATTERING AT 4.0 AND 5.0 GeV/c. Akerlof, C. W.; Han, K. S.; Meyer, D. I.; Schmueser, P. (Michigan Univ., Ann Arbor. Harrison M. Randall Lab. of Physics); Kirk, P. N.; Rust, D. R.; Ward, C. E. W.; Yovanovitch, D. D. (Argonne National Lab., Ill.); Pruss, S. M. (National Accelerator Lab., Batavia, Ill.). [1970]. 7p. Dep. NTIS

A wire spark chamber study is made of the differential cross sections for $K^+ + p$ elastic scattering at large angles at 4.0 and 5.0 GeV/c. (J.F.P.)

39573 (COO-1112-29) RECOIL INELASTIC PION SPECTRA RESULTING FROM 2.15 TO 6.00 GeV/c PI-MINUS PROTON INTERACTIONS. Anthony, Robert Wynne (Michigan Univ., Ann Arbor). 1971. 212p. Dep. NTIS.

Thesis.

A large optical spark chamber recoil spectrometer was used to study charged inelastic pion scattering from π^-p interactions. Eleven pion beam momenta, 2.15 through 6.0 GeV/c, were analyzed using primarily an automatic scanning and programed event recognition system. An independent, manual digitizing system assisted and spot checked the automatic system. The laboratory cross sections are presented for backward inelastic pion production for recoil pion momenta $P_{||}$ from elastic threshold down to 0.200 GeV/c and transverse momenta $P_\perp^2$ from 0.008 to 0.063 $(GeV/c)^2$. A Gaussian distribution exp $(-26.0\ P_\perp^2)$ fits the transverse momentum dependence of the cross section in this range of $P_\perp^2$ to within the overall ±10% angular uncertainty. From 3.95 GeV/c beam momentum onward, the laboratory recoil momentum spectra appear to be beam energy independent to within the combined statistical, and ±6% energy-to-energy systematic uncertainties. A comparison with other 25 GeV/c data for the reaction shows relative agreement with the laboratory cross sections projected to $P_\perp^2 = 0$. Moreover, recoil inelastic pions from 19.2 GeV/c $pp \rightarrow \pi^\pm$ + anything interactions are distributed similarly to the inelastic recoils. Various parameterizations of the recoil spectra at $P_\perp^2 = 0$ are possible. Three, which are mutually equivalent to the factorization $d^2\sigma/dMdU' \propto f(M)g(S)$ combined with asymptotic energy independence of the invariant cross section, are: the parameterization of Yang's hypothesis of limiting fragmentation (HLF) $E_\pi \cdot d^2\sigma/dP_{||}(dP_\perp^2)|_{lab} \propto (P_{||} - P_{||}(\infty))^{b''-1}$, where $P_{||}(\infty) = (M_\pi^2 - M_p^2)/2M_p$ is the infinite beam momentum elastic recoil threshold; the implied form of the factorization $d^2\sigma/dMdU' \propto M^{2b'-1}\ S^{-b}$, where M is the forward missing mass and S is the total center of mass energy squared; and finally the form predicted by the parton model for leading particles having X near unity $f(S,X,Q^2 = 0) \propto (1 - x)^{b'''-1} \equiv (1 - X)^{1-2\alpha}$, where X is $P_{||c.m.}/(\sqrt{S}/2)$. As the energy $S \rightarrow \infty$ these three parameterizations are shown to become equivalent with $b = b' = b'' = b'''$ = constant. Whenever the invariant cross section depends entirely on any combination of the four variables $P_{||lab}$, M^2/S, X, and U (the four-momentum transfer from the target proton to the recoil pion), the HLF is satisfied. Specifically, the baryon exchange contribution to the leading recoil pion cross section in the multi-Regge model of Caneschi–Pignotti satisfies HLF with their assumption of the Pomeranchuk trajectory representing the forward missing mass vertex. (auth)

39574 (COO-1112-34) RHO PRODUCTION AND DECAY IN THE REACTION $\pi^-p \rightarrow \pi^-\pi^0p$ AT 5 GeV/c. Byerly, L.; Anthony, R.; Coffin, C. T.; Meanley, E.; Meyer, D. I.; Rice, J.; Stanton, N. R.; Terwilliger, K. M. (Michigan Univ., Ann Arbor. Dept. of Physics). [1971]. 92p. (UM-HE-72-3). Dep. NTIS.

Production and decay distributions of ρ^- from $\pi^-p \rightarrow \pi^-\pi^0p$ were measured in an optical spark chamber experiment at 5 GeV/c. About 3000 events are obtained with $610 \leq \omega$(dipion mass) ≤ 910 MeV and $-.04 \geq t \geq -.35$ $(GeV/c)^2$. The data, and ρ^- and ρ^0 data from other experiments, are used to study the ω and t dependences of the helicity frame cross sections. It is found that $\rho_{00}^H d\sigma/dt$ and Re$\rho_{00}^H d\sigma/dt$ are the same for ρ^- and ρ^0 production except for an overall normalization factor and the ω distributions of $\rho_{11}^H d\sigma/dt$ and $\rho_{1-1}^H d\sigma/dt$ for ρ^- are strongly skewed toward low values of ω while the corresponding distributions for ρ^0 are not. The first result is shown to be reasonable in the context of a model assuming π and ω^0 exchange and absorption effects. The second result could not be explained. The forward–backward asymmetry of the ρ^- decay from this experiment is significantly smaller than values from some other experiments between 2.5 and 8 GeV/c. (auth)

39575 (COO-1112-35) MEASUREMENT OF THE DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS $\pi^+ + p \rightarrow K^+ + \Sigma^+$ AND $\pi^+ + p \rightarrow K^+ + Y^{*+}(1385)$ NEAR ZERO DEGREES AT 3.0, 5.0, AND 7.0 GeV/c. Kalbaci, Parviz (Michigan Univ., Ann Arbor. Dept. of Physics). 1971. 105p. (UM-HE-71-41). Dep. NTIS.

Thesis.

The differential cross sections for the reactions $\pi p \rightarrow K^+\Sigma^+$ and $\pi^+p \rightarrow K^+Y^{*+}$ were measured for kaon laboratory angles from 0 to 3.5°. A single-arm, missing-mass spectrometer determined the direction and momentum of forward going kaons. The spectrometer consisted of bending magnets, scintillation counters, gas threshold Čerenkov counters and wire spark chambers connected to an on-line computer. The differential cross sections for $\pi p \rightarrow K^+\Sigma^+$ rise exponentially to t_{min} at 5.0 and 7.0 GeV/c. However, the cross section at 3.0 GeV/c deviates from a simple exponential shape indicating a possibility of an s-channel contribution to the cross section. There is no evidence of a dip at very small $-t$ indicating that the spin flip contribution to the cross sections for this reaction is small. The results at high energies are compatible with double Regge pole models in the forward direction. The reaction $\pi p \rightarrow K^+Y^*$ shows a sharp dip at very small $-t$ indicating the dominance of the spin flip contribution to the cross section. The "ρ-photon analogy" was employed to interpret this forward dip. (auth)

39576 (INP–796) DIFFRACTION PRODUCTION PROCESSES IN K^+p INTERACTIONS. Eskreys, A. (Institute of Nuclear Physics, Krakow (Poland)). 1972. 123p. (In Polish). Dep. NTIS (U. S. Sales Only).

The K^+p diffraction dissociation processes were studied in the accelerator momentum range. The general properties of these processes were found to be similar to those observed in $\pi^\pm p$ and K^-p interactions. The cross sections for single and double dissociation processes were estimated, and it was found that already at the momentum of a few GeV/c some of the K^+p reaction channels are dominated by these processes. The spin analysis of the single dissociation processes $K^+ \rightarrow (K^+\pi^+\pi^-)$ and $p \rightarrow (p\pi^+\pi^-)$ in the reaction $K^+p \rightarrow K^+\pi^+\pi^-p$ at 5 GeV/c was performed and the Morrison spin-parity rule was confirmed. No evidence was found for the helicity conservation in the s or t reaction channels, for either process. The isospin analysis of the effective mass distributions and the analysis of the four-momentum transfer distributions for the $(K\pi\pi)^+$ and $(p\pi\pi)^+$ systems were performed. It was found that the resonance interpretation of the diffraction maximum is much more likely in the case of $(p\pi^+\pi^-)$ than in that of $(K^+\pi^+\pi^-)$. (auth)

39577 (JINR–P1-6326) STUDY OF THE SECONDARY PARTICLE MULTIPLICITY IN π^-p, π^-n, AND π^-C INTERACTIONS AT 40 GeV/c. Abdurakhimov, A. U.; Angelov, N.; Belyakov, V. A.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results are obtained on the multiplicity of charged secondary particles and neutral ones in π^-p, π^-n and π^-C collisions at the momentum of 40 GeV/c. The questions of technique of πN-event separation are discussed. (auth)

39578 (JINR–P2-6305) π^+p RADIATIVE SCATTERING AND MAGNETIC MOMENT OF ISOBAR $\Delta^{++}(1236)$. Vanzha, A. P.; Musakhanov, M. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

It has been proposed previously to use the π^+p radiative scattering for determining the $\Delta^{++}(1236)$ magnetic moment. However, this is possible only with some models. In the considered model Δ^{++} is a particle with spin $^3/_2$, minimal electromagnetic interaction, and anomalous magnetic moment. The previous notations of the Lagrangian (Γ_5) and the propagator (Γ_6) are used. The contribution of diagrams leads to the matrix elements $\epsilon_\mu(\mu_\mu^1 + \mu_\mu^2 + \mu_\mu^3 + \mu_\mu^{4'})$ which coincide with the corresponding previous expressions to within the terms $0[(E - M)/M, (E - M - W)/M]$. It appears that the additional term necessary for restoring gradient invariance has a given form. An expression for $\epsilon_\mu(\mu_\mu^4 + \mu_\mu^5)$ in the Δ^{++} framework is given. The differential cross section is given in the kinematics where the contribution of charges is depressed. (auth)

39579 (NEVIS–190) MEASUREMENT OF THE NEUTRAL PION FORM FACTOR SLOPE FROM THE DALITZ PAIR SPECTRUM. Burger, Joseph (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1972. 133p. (CU–296; R–794). Dep. NTIS.

Thesis.

The charged pion form factor slope was measured from a study of the invariant mass spectrum of 6044 e^+e^- pairs from the reaction $\pi^-p \rightarrow ne^+e^-$ at rest, using a magnetic pair spectrometer arrangement with sonic spark chambers at the Columbia–Nevis Synchrocyclotron. The result was slope = 0.017 ± 0.05 in units where $(M_\pi + M_p - M_n = 1)$ or alternatively $\langle r_\pi^2 \rangle = 0.208 \pm 0.61\ f^2$, where $\langle r_\pi^2 \rangle$ is the mean square pion charge radius. This result is consistent with ρ dominance, for which $\langle r_\pi^2 \rangle = 0.40\ f^2$. (auth)

39580 STUDY OF THE ELECTROMAGNETIC DECAYS OF PSEUDO-SCALAR AND VECTOR MESONS AND A STUDY OF THE PIZERO–PIZERO SYSTEM. Harvey, Everett Hilliard Jr. Minneapolis; Univ. of Minnesota (1971). 117p. University Microfilms Order No. 72-14,313.

Thesis.

The reaction $\pi^-p \rightarrow k\gamma + n$ where k is an integer from 2 to 4 was studied at a pion beam momentum of 3.65 GeV/c. This experiment was performed at the ZGS at Argonne National Laboratory using optical spark chambers. The gamma rays were detected in steel plate spark chambers and the neutrons in an array of scintillation counters and thin plate spark chambers. Single π^0 and η^0 production was found to be in excellent agreement with other measurements. Evidence for a dip in the differential cross section reaction $\pi^-p \rightarrow \eta^0n$ was found near $|t| = 1.5\ (\mathrm{GeV}/c)^2$. The decay $\eta' \rightarrow \gamma\gamma$ was observed and a branching ratio of $0.020^{+0.008}_{-0.006}$ was measured. Three gamma ray final states were fitted to $\pi^-p \rightarrow \pi^0\gamma n$ and $\pi^-p \rightarrow \eta^0\gamma n$. The reaction $\pi^-p \rightarrow (\omega^0 \rightarrow \pi^0\gamma)n$ was observed. Four gamma ray final states were fitted to $\pi^0\pi^0$, $\pi^0\eta^0$, and $\eta^0\eta^0$. (Diss. Abstr. Int., B)

39581 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS $\pi^+ + p \rightarrow K^+ + \Sigma^+$ AND $\pi^+ + p \rightarrow K^+ + Y^{*+}(1385)$ NEAR ZERO DEGREES AT 3.0, 5.0, AND 7.0 GeV/c. Kalbaci, Parviz. Ann Arbor, Mich.; Univ. of Michigan (1971). 104p. University Microfilms Order No. 72-14,907.

Thesis.

The differential cross sections for the reactions $\pi p \rightarrow K^+\Sigma^+$ and $\pi^+p \rightarrow K^+Y^{*+}$ were measured for kaon laboratory angles from 0 to 3.5°. A single-arm, missing-mass spectrometer determined the direction and momentum of forward going kaons. The spectrometer consisted of bending magnets, scintillation counters, gas threshold Cerenkov counters and wire spark chambers connected to an on-line computer. The differential cross sections for $\pi p \rightarrow K^+\Sigma^+$ rise exponentially to t_{min} at 5.0 and 7.0 GeV/c. However, the cross section at 3.0 GeV/c deviates from a simple exponential shape indicating a possibility of an s-channel contribution to the cross section. There is no evidence of a dip at very small $-t$ indicating that the spin flip contribution to the cross sections for this reaction is small. The results at high energies are compatible with double Regge pole models in the forward direction. The reaction $\pi p \rightarrow K^+Y^*$ shows a sharp dip at very small $-t$ indicating the dominance of the spin flip contribution to the cross section. The "ρ-photon analogy" was employed to interpret this forward dip. (Diss. Abstr. Int., B)

39582 $\bar{K}^0\pi^-$ FINAL STATES IN K^-d INTERACTIONS AT 4.9 GeV/c. Gourevitch, Sergei A. Cleveland; Case Western Reserve Univ. (1971). 100p. University Microfilms Order No. 72-6296.

Thesis.

An investigation of the following reactions: $K^-n \rightarrow \bar{K}^0\pi^-n$, $K^-n \rightarrow \bar{K}^0\pi^-MM$, $K^-d \rightarrow \bar{K}^0\pi^-d$, $K^-d \rightarrow \bar{K}^0\pi^-\pi^0d$ in a 5.43 evts/μb 4.93 GeV/c K^-d exposure taken at the Brookhaven National Laboratory Alternating Gradient Synchrotron in the 80-inch deuterium-filled bubble chamber is reported. Total and differential cross sections are given as well as production and decay parameters for the quasi two body final states $K^{*-}(890)n$, $\bar{K}^0\Delta^-(1238)$, $K^{*-}(1420)n$ and $K^{*-}(890)d$. The structure in the $\bar{K}^0\pi^-\pi^0$ mass spectrum is discussed with particular attention given to the Q region. The channel $K^-n \rightarrow \bar{K}^0\pi^-n$ was compared to the CRTT generalized Veneziano model. (Diss. Abstr. Int., B)

39583 ANALYSIS OF $K\pi$ SCATTERING FROM THE REACTION $K^+n \rightarrow K^+\pi^-p$. Firestone, A.; Goldhaber, G.; Lissauer, D.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Rev., D; 5: No. 9, 2188-97(1 May 1972).

An analysis was made of $K^+\pi^-$ elastic scattering in the reaction $K^+n \rightarrow K^+\pi^-p$ at 12 GeV/c. An extrapolation was made to the pion pole in order to obtain the on-mass-shell $K^+\pi^-$ elastic-scattering cross section and angular distributions as functions of $K\pi$ mass in the range from threshold to 2 GeV. Using a simple model of $k\pi$ elastic scattering solutions of the $I = ^1/_2$ S-wave phase shift were determined for $M(K\pi) < 1.7$ GeV. It is found that the $I = ^1/_2$ S-wave amplitude performs at least one complete loop in the Argand plot ("down" solution). In addition, if one chooses the appropriate "up" solutions, two rapidly varying loops at $M(K\pi)$ near the $K^*(890)$ and $K^*(1420)$, respectively, are also allowed by our data. (auth)

39584 ELASTIC SCATTERING AND SINGLE-PION PRODUCTION IN K^-p INTERACTIONS AT 5.5 GeV/c. Engelmann, R. (Argonne National Lab., Ill.); Musgrave, B.; Schweingruber, F.; (and others). Phys. Rev., D; 5: No. 9, 2162-87(1 May 1972).

Results are presented of an analysis of two-prong events for elastic scattering and single-pion production in K^-p interactions at 5.5 GeV/c. The resonance parameters for the charged and neutral $K^*(890)$ and $K^*(1420)$ are determined and the observed production and decay properties of the charged and neutral $K^*(890)$ are compared with the theoretical predictions of an absorptive one-particle-exchange model and a Regge model. The $K^*(1420)$ differential cross section and density-matrix elements are presented and the question of whether more than one resonance exists in this mass range is considered. A search for resonance effects at $K\pi$ mass beyond 1500 MeV is made. In particular, the recently reported state at 1800 MeV is discussed. A B_5-model analysis of the reaction $K^-p \rightarrow \bar{K}^0\pi^-p$.is also presented. (auth)

39585 RELATIVE CAPTURE RATES FOR SLOW π^-, K^-, Σ^- IN A NEON–HYDROGEN MIXTURE. Bugg, W. M. (Univ. of Tennessee, Knoxville); Condo, G. T.; Hart, E. L.; (and others). Phys. Rev., D; 5: No. 9, 2142-4(1 May 1972).

The relative hydrogen capture rates for π^-, K^-, and Σ^- in a 24 mole percent mixture of neon in hydrogen are found to be (17 ± 5)%, (26 ± 5)%, and (48 ± 6)%, respectively. A possible mechanism for these differences is presented. (auth)

39586 MULTIPLICITY DISTRIBUTIONS IN π^-p, π^-n, AND π^-C INTERACTIONS AT pc = 40 GeV. Bucharest-Budapest-Krakow-Dubna-Hanoi-Serpukhov-Sofia-Taskhent-Tbilisi-Ulan-Bator-Warsaw Collaboration. Phys. Lett.; 39B: No. 4, 571-4 (15 May 1972).

Results on multiplicity of charged particles produced in π^-p, π^-n and π^-C interactions at momentum p = 40 GeV/c are presented. The dependence of the average number of γ-quanta on the number of charged particles in π^-p and π^-n collisions is also given. (auth)

39587 MEASUREMENT OF NEUTRAL-MESON PRODUCTION IN $\pi^-p \rightarrow \pi^-pX^0$ AT 13.4 GeV/c. Thun, R. (State Univ. of New York, Stony Brook); Blieden, H. R.; Finocchiaro, G.; (and others). Phys. Rev. Lett.; 28: No. 26, 1733-5(26 Jun 1972).

The missing-mass technique was used to measure spectra of the neutral-meson system X^0 produced in $\pi^-p \rightarrow \pi^-pX^0$ at 13.4 GeV/c. The π^0, ρ^0, and ω^0 appear as well as a broad enhancement at 450 MeV and a narrow peak at 1280 MeV which is interpreted as the D^0. Most of the π^0 signal and the events around 450 MeV are correlated with N^{*+} production. The ρ^0 peak results primarily from A_1^-–A_2^- decays. It is found, however, that the ω^0 and D^0 are largely uncorrelated with N^{*+} or X^- resonances. (auth)

39588 STRANGE PARTICLES. Rushbrooke, J. G. (Cavendish Lab., Cambridge, Eng.); Walgate, R. G. J. Phys., E (London); 5: No. 6, 511-17(Jun 1972).

A simple bubble chamber experiment was used to introduce some basic ideas of elementary particle physics and special relativity. Measurements were made of the masses, lifetimes and branching ratios of certain short lived particles (the so-called "strange particles") produced in nuclear reactions. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 39703 and 39708.

39589 (COO–1764-148) FIRST AND SECOND FACTORIZATION IN A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Yu, S.; Baker, M. (Washington Univ., Seattle. Dept. of Physics); Coon, D. D. (Pittsburgh Univ., Pa. Dept. of Physics). [1971]. Contract AT(45-1)-1388. 45p. (RLO–1388-623). Dep. NTIS.

The N-point tree graphs of a dual resonance theory with nonlinear trajectories are factorized. The factorization procedure applies equally well with the external lines on or off the mass shell. The particle spectrum of the theory is found to have a degeneracy of approximately 6^l for the l^{th} level. Since the trajectory is logarithmic, the asymptotic density of levels grows only as some power of the mass. The techniques used in first factorization are applied to second factorization to arrive at an amplitude for processes involving two external particles with nonzero spins. Two sets of linear dependence relations among the amplitudes obtained by factorization are proven. (auth)

39590 (IFA–FT–90) BIAS FREE METHOD FOR THE DETECTION OF BOUND, ANTIBOUND AND RESONANT STATES FROM ERROR AFFECTED EXPERIMENTAL DATA. Caprini, I.; Ciulli, S.; Pomponiu, A.; Sabba-Stefanescu, I. (Institutul de Fizica Atomica, Bucharest (Romania)). 1971. 10p. Dep. NTIS (U. S. Sales Only).

It has already been recognized that, if the scattering amplitude is known only along a limited part of the cuts and with a limited accuracy, its analytic continuation to other points of its domain of holomorphy is not only nonunique but also unstable. The latter is a crucial fact both for the phenomenological analysis and for the theory, unless one is in the fortunate position to have a theory which predicts the amplitude at all energies at once. Indeed, as a consequence of the finiteness of the energy range, it is always possible to slip an infinite set of holomorphic functions inside the error-corridor, no matter how narrow it is, and which are such that they differ arbitrarily much at any other point of the holomorphy domain. However it is a remarkable mathematical fact that the maxima of the moduli of all these functions have to be greater than a certain lower-bound M_0, which is uniquely determined and which can be computed numerically from the data function and its errors. This number can be used as a sensitive device for the location of the singularities as well as the zeros of the scattering amplitudes in a way which avoids the "false particles" that might be produced by specific parametrizations (e.g., Breit–Wigner). The extreme sensitiveness of this bias-free method on two model amplitudes, one of which exhibits a pole and the other a zero in the complex energy plane, is exemplified. (auth)

39591 (ORO–3992-87) RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY. Progress Report. Sudarshan, E. C. G.; Ne'eman, Yuval (Texas Univ., Austin. Center for Particle Theory). [1970]. Contract AT(40-1)-3992. 57p. Dep. NTIS.

The summary of research on elementary particle theory covers particles traveling faster than light, scattering of shadow states, field theory, algebraic and group theory methods, strong interaction phenomenology, scattering theory, weak interactions, electrodynamics, computational methods, and a critical review of the development of modern physics. (J.F.P.)

39592 (SU–4205-263) RESEARCH PROGRAM IN ELEMENTARY PARTICLE THEORY. Progress Report for the Period Ending August 31, 1972. (Syracuse Univ., N. Y.). Contract AT(11-1)-3533. 32p. (COO–3533-1). Dep. NTIS.

Research is reported on theoretical high-energy physics and covers constraints on partial wave scattering amplitudes in unphysical and physical regions, the extension of the multiperipheral model to include charge and the development of refined techniques for more realistic calculations, chiral symmetry and its breaking, the widening of the scope of a unified theory of weak and electromagnetic interactions, and the application of a model with local duality to $\bar{K} + N$ scattering. A list of publications is included. (J.F.P.)

39593 ANALYTIC STRONG-COUPLING SOLUTIONS OF THE ABFST EQUATION. Dash, J. (Cambridge Univ., Eng.). Nuovo Cim.; 9A: No. 3, 265-82(1 Jun 1972).

Approximate, but explicit upper- and lower-bound strong-coupling solutions to the $t \neq 0$ ABFST equation are obtained. The Fredholm denominator $D_1(t)$ can be expressed as an infinite determinant of one-dimensional integrals in the narrow-resonance approximation. If expanded in a power series in t, the integrals can be performed, and the general structure of the solution of coupled $O_{3,1}$ equations emerges. The determinant is shown to be highly convergent, implying the effective decoupling of $O_{3,1}$ partial waves at $t \neq 0$, and verifying the approximate validity of the trace approximation. In special mass limits, closed expressions for the t^0-coefficient of D_1 are obtained. The basic approximation is kinematic rather than dynamic, and is expected to be accurate when the resonance mass m_0 is greater than all other masses and effective momentum transfers; here $m_0 \gg \mu$ (pion mass) and t not too large. This was shown to yield reasonable results for the leading trajectory. Even in the case $m_0 = \mu$, however, reasonable agreement of parent and daughter slopes are obtained with exact numerical results, and the $m_0 = \mu$ leading upper-bound intercept turns out to be given by the Tiktopoulos–Treiman upper bound. Results for residue functions are presented and their scaling properties are examined. The lower bound solutions provide a natural continuation from $q^2 = -\infty$ to $q^2 = 0$; the scale breaking mass being m_0. Finally, it is shown that the leading trajectory of the lower-bound solution is very close to that found by Swift and Tucker in their analysis of Polkinghorne's exact perturbation theory results. (auth)

39594 COMMUTATION OF AXIAL CHARGE WITH AXIAL DIVERGENCE. Khanna, Mohinder P. (Panjab Univ., Chandigarh, India). Progr. Theor. Phys. (Kyoto); 47: No. 2, 735-6 (Feb 1972).

The D/F ratio for the matrix elements of the axial vector divergence between two baryon states is obtained from saturation of current algebra sum rules with low-lying intermediate states Σ°, Λ°, and $\gamma^{*\circ}$, and with Σ^-, γ_1^{*-} and Σ^+, γ_1^{*+}. (L.B.S.)

39595 CLASS OF LINEAR RELATIVISTIC WAVE EQUATIONS DESCRIBING PARTICLES WITH SPIN ½. Chandrasekaran, P. S.; Menon, Nalini B.; Santhanam, T. S. (MATSCIENCE, Madras). Progr. Theor. Phys. (Kyoto); 47: No. 2, 671-7(Feb 1972).

The earlier theories on linear relativistic wave equations for particles with arbitrary spin are re-examined so as to admit a class of inequivalent equations describing particles with spin ½. (auth)

39596 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 9, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 70p.

39597 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 10, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 77p.

39598 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 8, 1972. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 84p.

Electromagnetic

Refer also to abstracts 39552, 39557, and 40181.

39599 (DESY-72/1) VECTOR MESON DOMINANCE, PHOTO- AND ELECTROPRODUCTION FROM NUCLEONS. Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan 1972. 83p. Dep. NTIS (U. S. Sales Only).

The lectures cover the basic assumptions of the vector meson dominance model, the $\gamma\rho$, $\gamma\omega$, and $\gamma\phi$ coupling constants, $e^+ + e^-$ annihilation beyond ρ^0, ω, and ϕ, single pion and $\pi\Delta(1236)$ photo- and electroproduction, vector meson dominance predictions from smoothness of invariant amplitudes, and the total photoproduction and electroproduction cross sections and vector meson production. (J.F.P.)

39600 (LNF-71/92) FINAL-STATE INTERACTIONS IN PHOTOPRODUCTION ON DEUTERIUM. Baldini-Celio, R.; Sciacca, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 20 Dec 1971. 35p. (In Italian). Dep. NTIS (U. S. Sales Only).

The basic theory of the impulse approximation is reviewed in the light of the most recent theoretical results on the three-body problem. In this framework, the corrections to the impulse approximation and particularly the correction due to the final-state reaction are then calculated. These calculations are repeated with other procedures. Comparisons are made with experimental data. (tr-auth)

39601 SOFT-PION PRODUCTION IN ELECTRON-POISTRON COLLISIONS. Goble, Robert L.; Rosner, Jonathan L. (Univ. of Minnesota, Minneapolis). Phys. Rev., D; 5: No. 9, 2345-58(1 May 1972).

The processes $\gamma \rightarrow \pi^+\pi^-$, $\gamma \rightarrow \pi^+\pi^+\pi^-\pi^-$, $\gamma\gamma \rightarrow \pi^+\pi^-$, and $\gamma\gamma \rightarrow \pi^+\pi^+\pi^-\pi^-$ can now be studied in $e^+ - e^-$ colliding-beam experiments. Amplitudes for these processes are considered in the low-energy region where simple analyticity may be used to extrapolate from the zero-energy values determined by gauge invariance and current algebra. It is argued that in the S-wave two-pion state a broad σ resonance will appear as an enhancement in $\gamma\gamma \rightarrow \pi^+\pi^-$ at an energy much lower than the σ mass. For the process $\gamma \rightarrow \pi^+\pi^+\pi^-\pi^-$ an approximation is made (which amounts to an extreme interpretation of ρ dominance) to predict a cross section of about 1.6×10^{-34} cm^2 at energies just above the ρ mass. A similar approximation is used to estimate the nonresonant cross section for $\gamma\gamma \rightarrow \pi^+\pi^+\pi^-\pi^-$, in substantial accord with a recent result by Terazawa. This cross section is found to be too small [O(10^{-36} cm^2)] to be of present experimental interest. (auth)

39602 INVESTIGATION OF THE VERTICES $\pi^0\gamma\gamma$, $\eta\gamma\gamma$, AND $\eta'\gamma\gamma$ WITH ELECTRON-POSITRON STORAGE RINGS. Parisi, J. (Univ., Paris); Kessler, P. Phys. Rev., D; 5: No. 9, 2229-37 (1 May 1972).

The creation of pseudoscalar particles (π^0, η, η') through photon-photon collisions in electron-positron storage rings is studied according to the original idea of Low. It is suggested that the outgoing electron and positron should be detected in their nearly forward directions, in coincidence with two photons (from the decay of the pseudoscalar particle produced) emitted at large angle. Assuming realistic experimental cutoffs, it is shown that (a) the integrated cross sections should be high enough to justify experiments of this type with future electron-positron storage rings of beam energy 1 to 3 GeV and luminosity $\sim10^{32}$ cm^{-2} sec^{-1}; (b) the background due to double bremsstrahlung is made negligible through our choice of the kinematic conditions. The interest of these experiments is discussed, and details of calculation are given. (auth)

39603 TEST OF THE ALGEBRA OF BILOCAL CURRENTS. Terazawa, Hidezumi (Rockefeller Univ., New York). Phys. Rev., D; 5: No. 9, 2259-64(1 May 1972).

It is proposed to use the inclusive two-photon process, $e^\pm + e^- \rightarrow e^\pm + e^-$ + hadrons, as a test of the algebra of bilocal currents and it is shown how to eliminate the background. (auth)

39604 WEAK AND ELECTROPRODUCTION OF NUCLEON RESONANCES IN THE HARMONIC-OSCILLATOR QUARK MODEL. Abdukkah, Tariq (Oxford Univ.); Close, Francis E. Phys. Rev., D; 5: No. 9, 2332-45(1 May 1972).

Using the model that the baryons are composed of quarks with harmonic interactions, cross sections are computed for high-energy neutrinos and electrons to excite the nucleon to the resonance states with masses below 1.9 GeV. The frame dependence of the nonrelativistic quark-model results is emphasized and discrepancies between some previous model calculations of electroproduction form factors and data are shown to be due to the frame chosen. For neutrino production, the model predicts that a significant excitation of the second and third resonance regions will be seen from neutrons, but with proton targets only the $\Delta(1236)$ excitation will be observed. An interesting result of the electroproduction calculation is the prediction that the $P_{11}(1470)$, while suppressed at small t (and hence in photoproduction), will dominate over the $S_{11}(1550)$ and $D_{13}(1520)$ at large $t \gtrsim 1.5$ (GeV/c)^2. (auth)

39605 LOW-ENERGY THEOREM FOR $\gamma \rightarrow 3\pi$. Aviv, Ruvi (Univ. of California, Santa Barbara); Zee, A. Phys. Rev., D; 5: No. 9, 2372-88(1 May 1972).

A low-energy theorem relating $\gamma \rightarrow 3\pi$ to $\pi^0 \rightarrow 2\gamma$ is derived by using anomalous Ward identities and by using Schwinger's proper-time technique. The theoretical significance of this low-energy theorem is discussed. In particular, the theorem is meaningful only if the partially conserved axial-vector current anomaly is in fact responsible for the decay $\pi^0 \rightarrow 2\gamma$. (auth)

39606 WEAK-INTERACTION CORRECTIONS TO THE MUON MAGNETIC MOMENT AND TO MUONIC-ATOM ENERGY LEVELS. Jackiw, Roman; Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 5: No. 9, 2396-8(1 May 1972).

The weak contributions to the anomalous magnetic moment of the muon are calculated in a proposed theory of the weak and electromagnetic interactions. The result is finite and of order $\Delta g_\mu \approx 10^{-8}$, too small to be measured at present. The present agreement between theoretical and experimental values of the muon magnetic moment does not even rule out the possibility that the scalar meson required by this theory has a very small mass. If this mass were sufficiently small, then the scalar-meson field would produce shifts of the order of a hundred parts per million in muonic-atom energy levels. (auth)

39607 PHOTOPRODUCTION OF NEUTRAL VECTOR MESONS IN A REGGE-POLE MODEL WITH CUTS. Eremyan, Sh. S.; Amatuni, A. Ts.; Arakelyan, G. G.; Garyaka, A. P.; Zverev, A. M. (Erevan Physics Inst.). Phys. Rev., D; 5: No. 9, 2282-6(1 May 1972).

Photoproduction of vector mesons in $\gamma p \rightarrow \rho V^0$ reactions is considered in a model with P, P′, A_2, and π trajectories and PP cuts. The contributions of cuts are described phenomenologically; SU(3) symmetry is used for vertices. The results obtained are in good agreement with all existing experimental data. (auth)

39608 LOWER BOUND FOR THE HADRONIC CONTRIBUTION TO THE MUON MAGNETIC MOMENT. Auberson, G.; Li, Ling-fong (Rockefeller Univ., New York). Phys. Rev., D; 5: No. 9, 2269-76(1 May 1972).

A new lower bound is derived for the hadronic contribution to the anomalous magnetic moment of the muon. In spite of a careful treatment of the ρ-dominance region, the numerical improvement over a previous bound due to Langacker and Suzuki is not very significant. (auth)

39609 PARTON MODEL AND THE RATIO $\nu W_2^n \nu W_2^p$. Senju, Hirofumi; Kakuto, Akira (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 2, 708-10(Feb 1972).

The eN deep inelastic scattering is examined in the kinematic region where the parton model works. It is shown that a new condition is required in addition to the Drell-Levy-Yan condition in order to obtain agreement with experiment for the ratio of inelastic structure function of the neutron and proton. (L.B.S.)

39610 PRODUCTION OF A PION AND A BOSON RESONANCE WITH SPIN J IN ELECTRON-POSITRON ANNIHILATION. Iida, Mihoko; Kubo, Reijiro (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 733-5(Feb 1972).

It is shown that the calculated production cross sections for the production of a pion and a boson resonance with spin J in e^+e^- interactions increase asymptotically to give rise to violation of unitarity. A multiple vector-meson-dominance mechanism is suggested, which eliminates the singular behavior of the cross sections in the asymptotic limit. (L.B.S.)

39611 NOTE ON THE DIVERGENCE OF THE ELECTROMAGNETIC MASS SHIFT OF THE PROTON. Hirayama, Minoru (Toyama Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 2, 720-1(Feb 1972).

The connection between the divergence of the electromagnetic mass shift of the proton and the choice of a scaling variable of electromagnetic structure functions is discussed. It is suggested that the mass shift can be finite if the scaling variable $\tilde{\omega}$ takes the form $1/\tilde{\omega} = 1/\omega + M^2/\nu + O(1/\nu^{1+\epsilon})$, $\epsilon > 0$, where $\nu = p \cdot q$ and $\omega = -q^2/2\nu$. (L.B.S.)

39612 CONCERNING ONE POSSIBILITY OF DETERMINING THE CHARGE FORM FACTOR OF THE NUCLEON. Kulish, Yu. V. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 15: No. 5, 201-2(5 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 5, 286-7(5 Mar 1972).

A method is proposed for determining the electric form factor of the nucleon, based on an investigation of the process $ep \rightarrow en\pi^+$ at high energies s and small $|t|$ t is the square of the total energy of πN system in the c.m.s. of the produced hadrons. (L.B.S.)

39613 ELECTROMAGNETIC POLARIZABILITY OF THE PION. Terent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 5, 204-7(5 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 5, 290-3(5 Mar 1972).

The possibility of experimentally measuring the electromagnetic polarizability of the pion by determining the level shift in π-mesic atoms was recently pointed out. The theoretical value of the polarizability is obtained within the framework of the low-energy π-meson technique. The corresponding value for the energy shift in the 6h-5g transition in ^{81}Tl is obtained; it is noted that the experimental determination of this transition energy is feasible. (L.B.S.)

39614 COHERENT STATES OF A CHARGED PARTICLE IN A TIME-DEPENDENT UNIFORM ELECTROMAGNETIC FIELD OF A PLANE CURRENT. Dodonov, V. V.; Malkin, I. A.; Man'ko, V. I. (Lebedev Inst. of Physics, Moscow). Physica; 59: No. 2, 241-56(15 May 1972).

All invariants, the coherent states, and the Green function are constructed for a particle moving in time-dependent uniform perpendicular electric and magnetic fields. The transition amplitudes and probabilities between the "energy" levels and their generating functions are constructed too. The limit cases of the problem under consideration are considered. (auth)

39615 GENERALISATION OF THE THEORY OF THE SPIN MAXIMUM 1 PARTICLE TO THE CASE OF A CHARGED PARTICLE MOVING IN AN ELECTROMAGNETIC FIELD. Pereira, J. V. (CNRS, Paris). Int. J. Theor. Phys.; 5: No. 6, 447-58(1972).

It is found that there is a problem of compatibility when seeking a generalization for the relativistic equation of a charged particle with spin maximum 1. A method of overcoming the difficulties is considered, and the spinor equations to describe the spin maximum 1 particle of electric charge q moving in an electromagnetic field defined by the potentials A and V are derived and examined. (UK)

39616 EIKONAL APPROACH TO SCATTERING FROM COATED PERFECT CONDUCTORS IN A SPINOR FORMALISM. Rockmore, Ronald (Rand Corp., Santa Monica, Calif.). Int. J. Theor. Phys.; 5: No. 6, 429-36(1972).

The eikonal approach is applied to the problem of the scattering of electromagnetic waves from an excluded volume in the presence of a weak external potential. The scattering of electromagnetic waves is treated in the spinor formalism previously developed (Rockmore (1966)). The excluded volume is eventually taken to be a perfectly conducting cone, the external potential a coating of thickness δ, with complex dielectric constant ϵ', and permeability μ (tacitly assumed equal to 1). It is shown that to order $(N - 1)$, where $N = (\epsilon'\mu)^{1/2}$, the eikonal approach in the spinor formalism yields results equivalent to those obtained from the vector theory of Überall in the particular case of nose-on backscattering, using the eikonal function corresponding to "straight-line propagation." (auth)

39617 VECTOR DOMINANCE MODEL AND ITS EXPERIMENTAL VERIFICATION BY THE DECAY OF VECTOR MESONS TO AN ELECTRON–POSITRON PAIR. Khachaturyan, M. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Probl. Fiz. Elem. Chastits At. Yadra; 2: No. 3, 583-634(1972). (In Russian).

The methods and results of the investigation of $V \rightarrow e^+e^-$ decays of ρ, ω and φ-mesons generated in hadron–hadron and electron-positron collisions are discussed. (auth)

39618 NEUTRON AND PROTON FORM FACTORS. Hammer, C. L.; Weber, T. A. (Ames Lab., Iowa). Phys. Rev. Lett.; 28: No. 25, 1675-9(19 Jun 1972).

A possible explanation is given for the dipole behavior of the neutron and proton electromagnetic form factors. (auth)

39619 EVIDENCE FOR STRAY BARYONIC STATES FROM A STUDY OF $K^+\Lambda$ PHOTOPRODUCTION. Deans, S. R.; Jacobs, D. T.; Lyons, P. W.; Montgomery, D. L. (Univ. of South Florida, Tampa). Phys. Rev. Lett.; 28: No. 26, 1739-42(26 Jun 1972).

Strong confirmatory evidence is found for the existence of a D_{13} resonant state around 1670 MeV cm energy; and evidence, though somewhat weaker, is obtained for the existence of a stray baryonic F_{15} state recently conjectured by Donnachie. (auth)

39620 RADIATION EMISSION BY CHARGED PARTICLES IN THE FIELD OF A PLANE ELECTROMAGNETIC WAVE IN A MEDIUM. Arutyunyan, V. M.; Avetisyan, G. K. (Inst. of Physical Research, Erevan). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1639-47(May 1972). (In Russian).

The radiation emitted by charged particles in the field of plane electromagnetic wave in a medium with a refractive index $n_0 > 1$ is considered. The features of "spontaneous" radiation emission by a particle under electromagnetic wave capture conditions are investigated. Incoherent emission by a particle at a frequency of the main wave is suppressed as compared to the usual Cherenkov emission. Modulation of an initially homogeneous particle beam occurs in the field of a linearly polarized wave. It is shown by the self-consistent technique that the energy lost by the particles of deceleration (assuming $v_0 > c/n_0$) is necessarily transferred to the wave and as a result the wave is intensified. Various conditions of amplification of light in a medium with a constant n_0 are determined. Numerical estimates show that over a length of ~1 cm the additional radiation transferred to the wave exceeds (by an order of magnitude) the intensity of the main wave. (auth)

39621 SOLUTIONS OF THE RELATIVISTIC TWO-BODY PROBLEM. I. CLASSICAL MECHANICS. Cook, J. L. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 25: No. 2, 117-39(Apr 1972).

The chief difficulty of lack of simultaneity of events in all Lorentz frames in relativistic mechanics is overcome using a proper time calibration method. The electromagnetic and gravitational point source interactions are derived. A Lagrangian and Hamiltonian formalism is shown to be valid. The mechanics can be quantized easily. Relativistic corrections are applied to the problem of planetary motion, a model for the relativistic Coulomb interaction is explored, and the relativistic harmonic oscillator is evaluated. (auth)

39622 CHERENKOV FIELD OF A UNIFORMLY CHARGED THIN DISC MOVING THROUGH A HOMOGENEOUS DISPERSIONLESS DIELECTRIC. I. Schnizer, Bernhard (Institut fuer Theoretische Physik und Reaktorphysik, Graz). Acta Phys. Austr.; 34: No. 1-2, 48-64(1971).

Explicit formulas are derived for the Čerenkov field of a uniformly charged infinitely thin rigid circular disc moving with its plane perpendicular to the constant velocity through a homogeneous dispersionless dielectric. They involve complete elliptic integrals of the first, second and third kind whose moduli are complicated functions of the coordinates. Shock waves starting from the rim of the disc cut the space occupied by the field into three regions. The behavior of the field at these wave fronts is investigated. There it either has finite jumps fulfilling the corresponding jump relations for weak solutions or becomes logarithmically infinite. Some Fourier transforms of products of two Bessel functions occurring in the field representations are evaluated. (auth)

39623 FIRST INTEGRAL OF THE KINETIC EQUATION FOR DISSIPATIVE SYSTEMS IN A MAGNETIC FIELD. Morozov, D. Kh. (Inst. of Medical-Biological Problems, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1733-6(May 1972). (In Russian).

It is well known that in dissipative systems phase density is not a first integral, i.e., it is not conserved along the characteristics. The purpose was to find the first integral of the kinetic equation for dissipative systems. The first integral of the kinetic equation for a set of noninteracting particles in an arbitrary magnetic field losing energy through radiation, ionization of the medium etc. is found. If energy is spent on ionization of the medium, allowance can also be made for collisions with nuclei resulting in disappearance of the particle. (auth)

Weak

Refer also to abstracts 39692, 39728, and 39729.

39624 (IFA-FT-94) SIMPLE BOUND FOR K_{l3} DECAY PARAMETERS USING THE $\pi K(s = 0, T = 1/2)$ PHASE SHIFT. Micu, M.; Radescu, E. (Institutul de Fizica Atomica, Bucharest (Romania)). Mar 1972. 6p. Dep. NTIS (U. S. Sales Only).

Taking as known the value of the propagator of the divergence of the weak strangeness-changing vector current at zero momentum transfer (t = 0) and the phase of the divergence K_{l3} form factor d(t) in the elastic region (where it is given by the phase of the s = 0, T = $\frac{1}{2}$ πK scattering), one finds a simple bound for d′(t = 0) which gives a stronger restriction on the K_{13} parameters than the one originally obtained by Li and Pagels. (auth)

39625 PRODUCTION AND DECAY OF WEAK SCALAR BOSONS IN VERY HIGH ENERGY COSMIC RAY INTERACTIONS. Ellis, John Limber. Toledo; Univ. of Toledo (1971). 125p. University Microfilms Order No. 72-16,247.

Thesis.

A discrepancy in the sec θ law for the distribution of muons of energies greater than 1000 GeV was observed. There appears to be an isotropic component whose intensity is about one-half the total integral muon spectrum at energies of about 2000 to 3000 GeV. This isotropic component can be most easily explained as being due to the production and subsequent decay into muons of a heavy particle, such as the exchange particle of the weak interactions. This particle must either be extremely short lived or not enter into any strong interactions or it would also obey a sec θ law. An attempt is made to explain this discrepancy as due to the production and decay of the exchange particle in a scalar boson theory of the weak interactions. The production of this scalar boson as well as the pions which produce the sec θ component of the muon spectrum is assumed to arise from the statistical decay of "fireballs" produced in pairs in high-energy proton–proton collisions. The production of the fireballs is assumed to follow from a Regge exchange between the two protons. In order to define the two fireball statistical decay model it was required to give the qualitative aspects observed for high-energy cosmic ray interactions. These included the average multiplicity of particles produced in these collisions, the constancy of the average transverse momentum of these same particles and the spectral index of muons produced from the decay of pions. Once this model was defined it was used to predict the muon spectrum from the decay of the scalar bosons. However it was found that no values of the masses of the particles or the coupling constant which must be introduced in this scalar boson theory would allow for the production of sufficient numbers of muons to explain the discrepancy. In fact the two fireball statistical decay model would not provide for the production of sufficient numbers of any heavy particles, even if they are produced strongly, to allow their subsequent decay into muons to explain the deviation from the sec θ law. (Diss. Abstr. Int., B)

39626 CURRENT ALGEBRA AND NONLEPTONIC HYPERON DECAYS: A FRESH APPROACH. Scadron, Michael D.; Thebaud, Lawrence R. (Univ. of Arizona, Tucson). Phys. Rev., D; 5: No. 9, 2306-10(1 May 1972).

It is shown how to obtain consequences of current algebra for nonleptonic hyperon decays in the limit $q^2 = 0$, with the baryons kept on the mass shell. The p waves are model-independent, and an excellent fit determines the parity-conserving spurion. When a K* pole is included for s waves, a rough fit is achieved. (auth)

39627 MODEL OF TANIKAWA et al. IN THE μ^-p RESONANCE AND DUALITY IN WEAK PROGRESSES. Miyatake, Toshio (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 726-7(Feb 1972).

It is shown that the β-decay process can be treated as a scattering process with the dual resonance model and by applying it to such low energy processes the number of assumed parameters can easily be decreased. (L.B.S.)

39628 UNSUBTRACTED DISPERSION RELATIONS AND NONLEPTONIC DECAYS. Kohara, Yoji; Nishijima, Kazuhiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 648-70(Feb 1972).

On the basis of CP invariance, octet dominance and unsubtracted dispersion relations nonleptonic decays of hyperons studied. A new interpretation of the Lee-Sugawara sum rule is proposed for both S- and P-wave decays, and the decay amplitudes are evaluated. The agreement between theory and experiment is reasonably good. (auth)

39629 DEEP INELASTIC LEPTON–NUCLEON INTERACTIONS. Wang, C. P. (Cambridge Univ., Eng.); Lin, A. L. L. Lett. Nuovo Cim.; 4: No. 3, 93-9(20 May 1972).

The differential and total cross sections and structure functions for deep inelastic neutrino- and antineutrino–nucleon interactions and quantitative relations among the deep inelastic eN, νN, and $\bar{\nu}$N interactions are obtained using the three-quark-boson-nucleon model constructed previously from deep inelastic eN scattering. (J.F.P.)

39630 $K_2^0 \rightarrow \gamma\gamma$ DECAY IN A CURRENT–CURRENT QUARK MODEL. Rockmore, R.; Wong, T. F. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev. Lett.; 28: No. 26, 1736-9 (26 Jun 1972).

The fermion-loop model introduced by Steinberger to explain the decay $\pi^0 \rightarrow \gamma\gamma$ is suitably modified for weak interactions so that it provides a qualitative explanation for $K_2^0 \rightarrow \gamma\gamma$ as well. The mean Hamiltonian is phenomenologically constructed from the one-baryon octet matrix elements of the symmetric quark model. Since these parameters are fitted to the nonleptonic decay of hyperons, this is a model for $K_2^0 \rightarrow \gamma\gamma$ with no adjustable parameters. (auth)

Strong (General)

39631 (ITF–71-112-P) ONE-PARTICLE DISTRIBUTIONS IN THE DUAL RESONANCE MODEL. Demchenko, G. P.; Struminskii, B. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

One-particle momentum distributions are considered on the basis of dual resonance model. The general form of the B_6-function discontinuity is obtained. All calculations are carried out in the physical region of the inclusive reaction. The results support the hypothesis about the existence of limiting momentum distributions of secondary particles. (auth)

39632 (ITF–71-118-P) DUAL RESONANCE MODELS. II. APPLICATION TO INELASTIC PROCESSES. Enkovskii, L. L.; Timokhin, V. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 52p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results and problems in the application of dual resonance models to inelastic processes are reviewed. (auth)

39633 TWO-PARTICLE CORRELATION AND THE ASSOCIATED MULTIPLICITY. Nieh, H. T.; Wang, Jiunn-ming (State Univ. of New York, Stony Brook). Phys. Rev., D; 5: No. 9, 2226-9(1 May 1972).

The study of the final hadron multiplicity as a function of s and the momentum of one of the final particles is proposed. It is pointed out that this information can reveal some qualitative features of the two-particle correlation function. Predictions of general classes of models concerning this multiplicity are also pointed out. (auth)

39634 SURVEY OF INCLUSIVE DISTRIBUTIONS IN A DUAL-RESONANCE MODEL. Thomas, G. H. (Argonne National Lab., Ill.). Phys. Rev., D; 5: No. 9, 2212-20(1 May 1972).

From a numerical survey of the dual-resonance model (DRM), it is found that (i) scaling in the central region is approached much more slowly than in the fragmentation regions due partially to kinematics, and partially to the overlap of the two fragmentation regions; (ii) the triple-Regge limit of the model remains a good approximation over most of the fragmentation region, if it is multiplied by a simple modulating factor. The physical origin of such a factor deserves theoretical attention. (iii) If the exchange picture is taken seriously, one should expect wrong-signature-nonsense-zero dips in reactions such as $\pi^- + p \rightarrow \pi^0 + X$ for $x \gtrsim 0.2$. The phenomenological implications of the DRM are also discussed. (auth)

39635 SYSTEMATICS OF ODD-ISOSPIN COMBINATION OF n-PARTICLE PRODUCTION CROSS SECTIONS. Nussinov, S. (State Univ. of New York, Stony Brook). Phys. Rev., D; 5: No. 9, 2221-5(1 May 1972).

A large class of multiperipheral models (MPM) is shown to predict a striking pattern for the distribution of a total cross-section difference among states of various multiplicities. Though the relevant experimental information in this case is much inferior to the corresponding information on over-all multiplicity distributions, the present approach may yield rather crucial tests of the model. While the general pattern predicted by the MPM seems to agree with the available data, the detailed numerical predictions of the magnitude of the cross-section difference fail, indicating a large diffraction component in the various isospin-even cross-section combinations. (auth)

39636 DOUBLE-REGGE BOUNDARY CONDITION FOR LIMITING FRAGMENTATION. Brower, Richard C. (Massachusetts Inst. of Tech., Cambridge); Ellis, John. Phys. Rev., D; 5: No. 9, 2253-7(1 May 1972).

By comparing the single- and double-Regge limits applied by Mueller to inclusive limiting distributions, it is inferred that, in general, inclusive distributions will have dips in the central region. The shape, depth, width, and observability of such dips are discussed. (auth)

39637 CHIRAL AND DILATIONAL SYMMETRY BREAKING AND THE $\eta' \rightarrow \eta\pi\pi$ DECAY RATE. Weisz, P.; Riazuddin; Oneda, S. (Univ. of Maryland, College Park). Phys. Rev., D; 5: No. 9, 2264-9(1 May 1972).

Assuming the Gell–Mann ansatz for the structure of the hadronic energy density $\Theta_{00} = \bar{\Theta}_{00} + u + \delta$ with $u = \epsilon_0(S_0 + cS_8)$ belonging to a $(3,3^*) + (3^*,3)$ representation of $SU(3) \otimes SU(3)$, $c \approx -1.25$, and the additional ansatz δ = constant, an estimate for the decay rate, $\Gamma(\eta' \rightarrow \eta\pi\pi) \lesssim 0.2$ MeV, is obtained, assuming that the $\eta'(958)$ is the ninth pseudoscalar meson. (auth)

39638 CROSS OVER AND SHRINKAGE FOR HADRON–HADRON ELASTIC SCATTERING. Nagai, Hiroyuki (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 2, 730-1(Feb 1972).

Some improvements are made in a simple optical model for explaining the cross over behavior and shrinkage of the cross sections and the inelasticities for hadron-hadron interactions. Two cases are examined: unequal potential ranges and peripheral-type potential. (L.B.S.)

39639 QUASISTABILITY OF THE POMERON. Fujisaki, Haruo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 47: No. 2, 619-25(Feb 1972).

The possible quasistability of the (partially-) self-reproducing Pomeron is investigated by the use of the modified Gribov-Pomeranchuk-Ter-Martirosyan parametrization. A simple bootstrap model of the quasistable, self-reproducing Pomeron is proposed. Another model which yields the quasistable, partially-self-reproducing Pomeron is also studied. Both of these models are inevitably based on the modified Gribov-Pomeranchuk-Ter-Martirosyan parametrization. (auth)

39640 SOME ASPECTS OF MULTIPLE PARTICLE PRODUCTION AT ULTRAHIGH ENERGIES. Shivpuri, R. K. (Clarkson Coll. of Tech., Potsdam, N. Y.). Particles Nucl.; 3: No. 5, 285-90(May 1972).

It is found that the Fermi or fireball model is inadequate to explain certain features of multiple particle production at ultrahigh energies ($\sim 10^{12}$ eV). On the basis of Feynman's parton model, arguments are presented below to explain the behavior of various parameters like asymmetry, transverse and longitudinal momentum distribution of secondary particles. (auth)

39641 OPTICAL MODEL AT HIGH ENERGIES. Islam, Muhammad M. (Univ. of Connecticut, Storrs). Phys. Today; 25: No. 5, 23-7(May 1972).

The topics discussed include field theory models leading to the optical model with examples of N + N interactions, the Regge optical model, the droplet model with hadron scattering described as one Lorentz-contracted pancake passing through another, and the nucleon substructure in the optical model. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstract 39567.

39642 (COO-1112-59) SELECTION RULE FOR REGGE–REGGE CUT. Henyey, F. S. (Michigan Univ., Ann Arbor. Dept. of Physics); Kane, G. L. (Rutherford High Energy Lab., Chilton (England)). [1971]. 8p. (UM-HE-71-50). Dep. NTIS.

Finkelstein's recently proposed selection rule for Regge cuts implies the following stronger selection rule in meson–meson-scattering: Regge–Regge cuts can contribute only to processes of the two (related) types $ab \rightarrow b'a'$ or $a\bar{a}' \rightarrow b'\bar{b}$, where a′ and b′ have the same quark content as a and b respectively. This selection rule is (roughly) the converse of the assertion that the Pomeron is dual to Regge–Regge cuts. The selection rule (and Finkelstein's) is violated in dual field theory and is inconsistent with a relation involving cuts and fixed poles. (auth)

39643 (ITF–71-120-E) ANNIHILATION $N\bar{N} \rightarrow 3\pi$ IN DUAL MODELS. Bugrii, A. I.; Enkovskii, L. L.; Kobylinskii, N. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The reaction $N\bar{N} \rightarrow 3\pi$ is studied for moments of the incident antiproton 1.2 GeV in the framework of the Veneziano model with satellites and a dual amplitude with Mandelstam analyticity (DAMA). The theoretical predictions are compared with experimental data. (auth)

39644 (ITF–71-123-E) NEW MODEL FOR THE POMERON AND THE ISR DATA. Ilyin, V. V.; Enkovskii, L. L.; Kobylinskii, N. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 11p. Dep. NTIS (U. S. Sales Only).

A new model for the Pomeron is investigated in which the exotic and the Pomeron trajectories are mirage trajectories bounded from above. The model is compatible with the new ISR data on the slope of the diffraction cone. (auth)

39645 SU(3) MASS DIFFERENCES, RENORMALIZATION PROBLEM, AND TADPOLE RESULTS IN FIFTH INTERACTION. Goyal, Ashok Kumar. Philadelphia; Univ. of Pennsylvania (1971). 138p. University Microfilms Order No. 72-6154. Thesis.

The medium strong mass splittings for pseudoscalar mesons, vector mesons and spin $^3/_2$ baryons are examined in the framework of the "fifth interaction" proposed by Ne'eman. In addition to the resonance contributions from the low lying states, an expression is written for the contribution from f_8 Regge exchange in terms of contributions to electromagnetic mass differences from A_2^0 Regge exchange. Assuming A_2^0 Regge pole gives correct contribution to the e.m. mass differences, the contribution of the f_8 meson is estimated. In the approximation of neglecting the continuum spectrum, the ratio of tadpole contribution is given by the ratio of coupling constants of f_8 meson with hadrons. The results of tadpole model are in agreement with the subtraction scheme of Segre. It is also found that in the presence of such an SU(3) symmetry breaking term, the renormalization of hadronic-weak strangeness-changing vector current vertex, to second order in such a term, is quadratically divergent. On the basis of the calculations for deviations from G.M.O. mass formula in the soft meson limit, it is found that a value of M_X^2 of the order of 5 to 10 $(GeV)^2$ is not unreasonable. (Diss. Abstr. Int., B)

39646 COMMENTS ON DUALITY AND THE FINAL-STATE-INTERACTION APPROACH TO $N\bar{N} \rightarrow 3\pi$. Sivers, Dennis (Argonne National Lab., Ill.). Phys. Rev., D; 5: No. 9, 2392-5(1 May 1972).

Duality suggests that it is more informative to factorize an amplitude for $N\bar{N} \rightarrow 3\pi$ at the exchanged nucleon poles than at a direct-channel singularity. Experimental verification of t-channel factorization and the implications for the final-state-interaction approach to $N\bar{N}$ annihilations are discussed. (auth)

39647 DUAL REALISTIC QUARK MODEL. Bando, Masako; Machida, Shigeru; Nakkagawa, Hisao; Yamawaki, Koichi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 626-47(Feb 1972).

Spin-, unitary spin-, and momentum-dependences of N-point meson amplitudes are obtained, using the "realistic quark model" in which the quarks are assumed to have the following properties; definite unitary spin, spin, coordinate and statistics. Furthermore cyclic symmetry of hadron external lines and factorization at the hadron poles are assumed, which lead to the same unitary spin dependence as in the case of the "mathematical quark model" in which the quarks are only considered as a mathematical symbol. As for the spin dependence, however, serious differences to appear; many of the difficulties of the mathematical quark model are removed and in the case of π-π scattering, the factor required from the high energy behavior is naturally derived from our spin factor. A reasonable form of "the spatial part" of the scattering amplitude is also offered, assuming a certain symmetry at the quark level. (auth)

39648 DUAL AMPLITUDES AND BASIC ASSUMPTIONS. I. Kitazoe, Tetsuro; Shinohara, Hideyuki (Kobe Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 2, 603-18(Feb 1972).

Four simple assumptions for scattering amplitudes are proposed in order to derive dual amplitudes. The assumptions are conventional except the one which states that each term of an amplitude, corresponding to a certain combination of Regge poles in s, t and u channels, is constructed by a triple product form of three unknown functions, $g_1(t)$, $g_2(s)$ and $g_3(u)$. This is arrived at by an abstraction from Virasoro type amplitudes. These assumptions lead to difference equations for g's, which can be solved. It is found that the amplitude can be uniquely determined and that it coincides with the amplitudes of Virasoro type and with the ones of Veneziano type when the sums of the trajectories in s, t and u channels are determined by isospin crossing considerations. Examples are given for $\pi\pi \rightarrow \pi\omega$ scattering and $\pi N \rightarrow \pi N$ scattering. For the latter, it is shown that the A amplitude (in usual notation) obtained coincides with the one proposed by Igi and Hara, but B does not. It is concluded that some daughter trajectories of N and Δ must contribute to the B amplitude. Also the basic assumptions generally exclude the terms with P′, N and Δ trajectories for the A amplitude and the terms with ρ, N and Δ trajectories for the B amplitude, which suggests possible existence of some kinds of selection rules. (auth)

39649 EXTENDED-BOSON EXCHANGE AMPLITUDE ASSOCIATED WITH HYDROGEN-LIKE REGGE RECURRENCE. Ueda, Tamotsu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 572-88(Feb 1972).

An extended boson is introduced which is represented by a bilocal field associated with a hydrogen-like Regge recurrence, and an extended-boson-exchange model is proposed for non-diffractive part of N-N and N-$\bar{N}$ interactions. The proposed model amounts to the Regge-pole model at forward angles at high energy and reduces to the one-boson-exchange model at low energy. (auth)

39650 HELICITY AMPLITUDES FOR ANTIBARYON–BARYON SCATTERING. III. Weiner, Richard M. (Indiana

Univ., Bloomington). Particles Nucl.; 3: No. 5, 264-84(May 1972).

The expressions for helicity amplitudes for the reactions $\bar{p}p \rightarrow \bar{\Sigma}^0\Sigma^0$, $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$, $\bar{p}N \rightarrow \bar{\Lambda}\Sigma^-$ are given in terms of quark helicity amplitudes assuming the scattering mechanism described in part (I) of this paper. (auth)

39651 POSSIBLE DIFFICULTIES WITH u-CHANNEL EXCHANGE DEGENERACY. Logan, R. K. (Univ. of Toronto). Can. J. Phys.; 50: No. 6, 529-30(15 Mar 1972).

The consequences of u-channel exchange degeneracy arising from a FESR bootstrap scheme were explored for the case of $\pi\bar{K}$ and $\pi\Xi$ backward scattering and a possible difficulty with the scheme was discovered. (auth)

39652 BEHAVIOR OF THE FORM FACTOR OF THE π MESON AND THE EXTENT OF ITS RADIUS. Tao Wong Tung; Nguyen Van Hieu. Probl. Fiz. Elem. Chastits At. Yadra; 2: No. 3, 533-82(1972). (In Russian).

In this review the consequences of the general analytical properties of the form factor which can be checked experimentally are studied. The following problems are considered: lower bounds on the form factor in the physical regions of the scattering and annihilation channels, connections between the behavior of the form factor in the physical region of the scattering channel and that of its modulus on the cut, exact sum rules for the form factor, and bounds on the radius of the elementary particles. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 39549.

39653 (COO-1112-61) INTEREST OF POLARIZATION IN MULTIPARTICLE PROCESSES. Drummond, I. T. (Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics); Kane, G. L. (Rutherford High Energy Lab., Chilton (England)). Jan 1972. 41p. (DAMTP-72/2). Dep. NTIS.

Some interesting results are considered which can be obtained for particle production amplitudes by measuring polarizations. Although many of the remarks are general, only the Λ-polarization in the processes $\pi(K) + P \rightarrow K(\pi) + \pi + \Lambda$ is discussed in detail. Considerable attention is given to what experimenters should measure, and how to interpret the direction of the Λ-polarization relative to the production plane. Possible interesting information that can be obtained includes detection of $K\pi$ resonances which do not show up in the cross section, determination of the normality of an exchanged particle between the nucleon–hyperon system and the meson system, and information on phases of production amplitudes such as phase variation due to Toller angle dependence. A complete formalism including separation to leading order in S of exchanges of different normality is given in terms of both invariant amplitudes and helicity amplitudes. Numerical calculations are given for some simple models to indicate the kinds of results which might be found experimentally. (auth)

39654 (COO-1112-62) INTERPRETATION OF THE HIGH-ENERGY πN SCATTERING AMPLITUDES AND DATA. Hartley, B. J. (Imperial Coll. of Science and Tech., London (England). Dept. of Physics); Kane, G. L. (Rutherford High Energy Lab., Chilton (England)). Mar 1972. 19p. Dep. NTIS.

The πN scattering amplitudes at 6 GeV/c are examined and physical interpretations are suggested. For isovector exchange they are shown to be correctly given by a conventional enhanced absorption model which takes into account the phase of the elastic scattering at the same energy, while for isoscalar exchange they are consistent with simple ideas in impact parameter space. The absolute phase of the isoscalar exchange is determined by internal consistency of the model, and a t dependence for the Pomeron is predicted. A number of general points are briefly discussed, including the mechanism causing the double zeros in the elastic polarizations, the importance of different effective trajectories for flip and nonflip amplitudes, the possibility that shrinkage will change with energy, the expectation that crossover zeros will move out with increasing energy, the origin of the isoscalar flip amplitude, and the peripherality of the amplitudes. (auth)

39655 (SU-4205-260) PION PRODUCTION IN THE MULTIPERIPHERAL MODEL. Amann, R. F. (Syracuse Univ., N. Y. Dept. of Physics). Mar 1972. Contract [AT(11-1)-3533]. 14p. (COO-3533-260). Dep. NTIS.

The momentum spectra of produced pions at different energies and in different reactions are compared to the predictions of a multiperipheral model that utilizes two parameters, a coupling constant and an exponential damping of each momentum transfer. The rapidity and $p_{\perp}$ distributions are successfully predicted in remarkable detail; the development of these distributions with increasing energy is discussed. (auth)

39656 PARTIAL WIDTHS AND BRANCHING RATIOS OF N*'s RESONANCES AS CALCULATED FROM THE PROCESS $\pi^+p \rightarrow K^+\Sigma^+$. Feuerbacher, John Larry. Nashville; Vanderbilt Univ. (1971). 117p. University Microfilms Order No. 72-15,472.

Thesis.

Work was done on the process $\pi^+ + p \rightarrow K^+ + \Sigma^+$ in order to learn more about new resonances recently discovered or suspected because of phase shift analysis. A pole-resonance type of model was used to calculate partial widths and branching fractions for the decay of N*'s resonances with masses below 2 GeV into a K^+ and a Σ^+. The Breit–Wigner form was used for the resonance terms. The differential cross section for the above process and the average polarization of the decay $\Sigma^+ \rightarrow p + \pi_0$ were fit to experimental data available on the process. The strengths of the resonances and poles were varied as parameters until the best fit to the data, according to the χ^2 test, was obtained. The partial widths and branching fractions were then calculated from the strengths of the resonances. The work resulted in further evidence for the existence of some of the new resonances, but failed to produce evidence for others. The partial width of the $F_{37}(1946)$ resonance was compared with values calculated by other authors. (Diss. Abstr. Int., B)

39657 PHYSICAL MESON SCATTERING ON BARYONS AND LIGHT NUCLEI. Hakim, Muhammad Shafik Ahmad Jalal. Ann Arbor, Mich.; Univ. of Michigan (1971). 166p. University Microfilms Order No. 72-14,883.

Thesis.

Use of the Fubini–Furlan extrapolation program is made to derive sum rules for πN, KN, $\bar{K}$N, $\pi\Lambda$ and $\pi\Sigma$ elastic scattering amplitudes. The threshold behavior of the sum rules in the canonical and Gell-Mann, Oakes and Renner's SU(3) ⊗ SU(3) breaking algebras is studied. In the first model the singlet term μ_0 is determined from experimental data to be ~286 MeV. The pion–nucleon sigma term was found to be 30.4. In the second model μ_0 was found to be ~232 MeV and the pion–nucleon sigma term to be 26.3 MeV. The results for the meson–baryon scattering-lengths in both models show a good agreement with experimental data and a major improvement over the soft meson results. The extrapolation program is extended to π^--nucleus scattering. Experimental data were used for the real and imaginary parts of the scattering length to evaluate the nuclear sigma term. In the impulse approximation the pion–nucleon sigma term is determined from each reaction tested. If one assumes that the lowest inelastic threshold proceeds by releasing one neutron out of the original system the average of the individual determinations of the sigma term $\bar{S}_{\pi n} = 13.4$ MeV is found. If one assumes that the lowest inelastic threshold proceeds by releasing a neutron–proton system $\bar{S}_{\pi n} = 15.3$ MeV is found. Using these values for the pion–nucleon sigma term the real part of the π^--nucleus scattering length is determined. The results show good agreement with experimental data. (Diss. Abstr. Int., B)

39658 RELATIVISTIC QUANTUM MANY-BODY THEORY IN RIEMANNIAN SPACETIME WITH APPLICATIONS TO SUPERDENSE MATTER. Bowers, Richard Lawson. Eugene, Oreg.; Univ. of Oregon (1971). 133p. University Microfilms Order No. 72-14,715.

Thesis.

A relativistic quantum many-body theory in Riemannian spacetime is constructed and discussed, and its application to a superdense system composed of strongly interacting elementary particles is considered. (TSS)

39659 SPIN AND PARITY ANALYSIS IN THE DOUBLE-REGGE MODEL. Froggatt, C. D. (Niels Bohr Inst., Copenhagen); Ranft, G. Phys. Rev., D; 5: No. 9, 2198-2212(1 May 1972).

The formalism is given for a partial-wave analysis of a low-mass two-body subsystem produced via a double-Regge amplitude at small momentum transfer. This method is applied to the Reggeized Deck amplitude for the reaction $\pi N \rightarrow \rho\pi N$ in the $\rho-\pi$ mass region of the A enhancement. At lower mass values the results are less sensitive to the exact form of the pion Regge trajectory, and about 75–80% of the cross section in the A_1 region is given by a 1^+ S-wave $\rho-\pi$ state. This amplitude is largely real and the Argand diagrams for the partial waves do not show resonant structure. However, phenomenologically it is difficult to distinguish between the Berger amplitude and an A_1-resonance production amplitude. The spin-parity decomposition in the A_2 mass region is also discussed. (auth)

39660 REGGE-POLE MODEL OF PION–NUCLEON SCATTERING WITH EXPLICIT QUARKS. Ellis, Stephen D. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 5: No. 9, 2366-72(1 May 1972).

A U(6)-symmetric Regge-pole model with explicit quark spin is applied to meson and baryon exchange in the πN system. Attention is focused on the general form of the polynomial residues which result from including the required projection operators. Detailed calculations are exhibited for forward charge-exchange scattering within the context of a dual model with fixed cuts. For the case of baryon exchange a Regge residue appropriate to the symmetric-quark-model spectrum is presented and studied. (auth)

39661 FIXED POLE AND SHIELDING CUT IN πN CHARGE EXCHANGE. Zaoui, Roger (Univ. of Maryland, College Park). Phys. Rev., D; 5: No. 9, 2358-66(1 May 1972).

A model for the relationship of a fixed pole to a shielding cut is constructed. In order to remove the constraints imposed by unitarity the following are required to hold in the limit $l \to l_0$: (1) The branch point of the shielding cut coincides with the elastic threshold. (2) The discontinuity of the amplitude on the elastic cut is singular and finite at the end point $l = \alpha_c(t)$ of the cut in the angular momentum plane. (3) This discontinuity contains the fixed pole. It is found that the fixed pole does not contribute to the asymptotic behavior in the crossed channel as it has been asserted, but the shielding cut gives a negative nonvanishing contribution at a wrong-signature point. Phenomenological implications are discussed in connection with dip-bump structure in the differential cross section, and the dependence of the polarization upon both energy and momentum transfer in πN charge exchange. It is found that the results agree with recent experimental results. (auth)

39662 COMPARISON OF THE MULTIPERIPHERAL MODEL WITH INCLUSIVE DATA IN K^+p AND π^-p REACTIONS. Friedman, Jerome H. (Univ. of California, Berkeley); Risk, Clifford. Phys. Rev., D; 5: No. 9, 2245-52(1 May 1972).

The predictions of the multiperipheral model are compared with inclusive data in K^+p and π^-p reactions. Comparisons are made with topological longitudinal-momentum distributions, double-differential distributions, multiplicity cross sections, π^+/π^- ratio, asymmetry characteristics, isotropy in the c.m. system, and Regge behavior near the kinematical limit. The agreement is reasonably good. The relation of this work to earlier work on the multi-Regge model, to results of other models, and to the results obtained by other types of approaches to the inclusive analysis is discussed. (auth)

39663 UNIFIED TREATMENT OF MESON–MESON, MESON–BARYON, AND BARYON–BARYON SCATTERING IN VENEZIANO MODEL. Roy, T.; Chowdhury, A. Roy (Jadavpur Univ., Calcutta). Progr. Theor. Phys. (Kyoto); 47: No. 2, 714-15(Feb 1972).

A method is suggested for overcoming the difficulties associated with the construction of Veneziano amplitudes for meson–baryon and baryon–baryon scattering with correct high-energy behavior, spin structure, duality, and crossing symmetry. Three cases are discussed: $\pi N \to \pi N$, $\pi N \to \pi\pi N$, and $\bar{N}N \to \bar{N}N$. (L.B.S.)

39664 PION DISTRIBUTIONS IN HADRON COLLISIONS: REREMARKS AND CALCULATIONS. Jasselette, P.; Vandermeulen, J. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 40: No. 5-8, 250-61(1971).

Recent experimental results and proposed interpretations of multiple emission of pions in high energy hadron collisions are reviewed. The results are reexamined in the light of a model proposed by Caneshi and Schwimmer to account for the multiperipheral character of the collision. It is shown that neither the assumption of uncorrelated pion production nor a simplified account of resonances can reproduce details of the experimental distributions beyond the prong number distribution. (auth)

39665 SOME CONSISTENCY QUESTIONS IN THE DERIVATION OF NUCLEON FORM FACTORS FROM POLE DOMINANCE AND VENEZIANO. Konetschny, W. (Institut fuer Theoretische Physik, Vienna). Acta Phys. Austr.; 34: No. 1-2, 102-9(1971).

The derivation of nucleon form factors in the Veneziano model, which has been given elsewhere, is revisited in order to clarify several points not discussed thoroughly in the former calculation. Also, a special model for the off-mass shell continuation is investigated. It is found that most of the conclusions of the first derivation are left unchanged by the more solid treatment presented. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 39747.

39666 (BNL–16804) LARGE Q^2 EXPERIMENTS AT ISABELLE. Lederman, Leon M. (Brookhaven National Lab., Upton, N. Y.). Sep 1971. 12p. Dep. NTIS.

The new domain of the variables s and Q^2 is treated where s is the square of the energy in the CM and Q^2 is the momentum transferred in the collision. Speculation is made on the existence of a graph containing a slope which relates cross section to threshold energy. The reactions $p + p \to \mu^+ + \mu^- +$ anything and $p + p \to \mu + \nu +$ anything are considered. A proposed experiment is described for cross sections for $p + p \to e^+ + e^-(\nu) +$ anything interactions. (J.F.P.)

39667 (ITF–71-103-E) NATURE OF THE DUAL POMERON AND NEW STORAGE RING DATA. Enkovskii, L. L.; Kobylinskii, N. A.; Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 14p. Dep. NTIS (U. S. Sales Only).

A formalism based on dual models is investigated in which the pomeron, the background and exotic states are described by Regge trajectories. Two alternative approaches are discussed in the framework of this formalism. Also, a new asymptotic behavior resulting from dual models is suggested. To meet the experimental situation it is necessary to satisfy one of the following requirements: the pomeron is a fixed pole; its trajectory has a left-hand cut; exotic trajectories are bounded from above. (auth)

39668 (JINR–P2-6376) ON THE RESCATTERING EFFECT IN $pd \to ppn$ REACTION. I. DIFFERENTIAL CROSS SECTIONS AT $T_p = 600$ MeV, SYMMETRICAL GEOMETRY. Golovin, B. M.; Lykasov, G. I.; Rozanova, A. M.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

In previous work the experimental data on the $pd \to 2p + n$ scattering differential cross section with $T_p = 600$ MeV and the symmetrical geometry of scattered particles have been presented. The differential cross section calculated within the framework of the "simple" impulse approximation agreed poorly with these data in the large momentum transfer region. It is shown that the impulse approximation succeeds in describing the above mentioned data provided the double scatterings of the incident particle from the deuteron nucleons and the spin dependence of the N–N amplitudes are taken into account. The calculated cross section coincides with the observable one within 2 to 3 experimental errors for all the considered scattering angles. (auth)

39669 (LNF–71/89) NUCLEAR ABSORPTION AND SECONDARY PARTICLE PRODUCTION CALCULATIONS. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 16 Dec 1971. 10p. Dep. NTIS (U. S. Sales Only).

Calculations of the pion nuclear reaction corrections for the boson experiment are given. The energy dependence of the absorption corrections and the effects of secondary particle production are treated. (J.F.P.)

39670 (ORNL–TM–3148) INELASTIC INTERACTIONS OF NUCLEONS AND π-MESONS WITH COMPLEX NUCLEI AT ENERGIES BELOW 3 GeV. Bertini, Hugo W.; Guthrie, Miriam P.; Culkowski, Arline H. (Oak Ridge National Lab., Tenn.). 28 Mar 1972. 136p. Dep. NTIS.

Inelastic interactions corresponding to continuum state transitions are calculated using the intranuclear-cascade-evaporation approach. Spallation yields, energy- and angular-dependent spectra, particle multiplicities, and inelastic cross sections are calculated for incident nucleons and π-mesons with energies below 3 GeV on complex nuclei. Comparisons with experimental data are made and, in general, the agreement is good. Discrepancies in these comparisons are discussed with respect to the deficiencies in the model. (auth)

39671 (ORO–4317-3) VARIATIONAL APPROACH TO THE ON- AND OFF-SHELL T-MATRIX. Technical Report No. 72-087. Sloan, Ian H.; Brady, T. J. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Mar 1972. 32p. Dep. NTIS.

A variational procedure for calculating the two-body t-matrix $T_l(p,p';s)$ is proposed, and studied numerically for the case of the Reid $^1S_0$ soft-core potential. The method is based on a variational principle of the Schwinger type, in which the trial functions are themselves off-energy-shell t-matrices with fixed s and p (or fixed s and p′), which are expressed as linear combinations of a convenient basis set. The variationally calculated t-matrix turns out to have the interesting form $T = V + VG'V$, where G' is a finite-rank approximation to the full Green's function, of rank equal to the number of basis functions. It also turns out that for potentials of finite rank the approximation is exact, provided that the space spanned by the basis functions includes the form factors of the potential. Numerical results are given for the Reid potential at energies from −50 to 300 MeV, and show good convergence for both on- and off-shell t-matrix elements. The nonvariational estimates obtained directly from the trial functions also converge quite well, but less rapidly than the variational results. (auth)

39672 HIGH ENERGY POLARIZED NEUTRONS FROM QUASI-FREE PROTON–DEUTERON SCATTERING. Ward, Dan

Sewell. Austin, Tex.; Univ. of Texas (1971). 93p. University Microfilms Order No. 72-15,849.

Thesis.

An extensive analysis was made of the inelastic scattering of high energy protons incident on deuteron targets resulting in the production of partially polarized, high energy neutrons. The basic intent of the investigation was to evaluate the charge exchange production of such neutrons and provide some theoretical predictions for use in future neutron beam production experiments. Using incident proton beams of 384, 450, 510, 600, 690, and 750 MeV, differential cross sections and polarizations were computed at neutron scattering angles of 0, 16, 20, 24, and 28° (lab). The basic mechanism of quasi-free scattering provided peaks in the cross section on the order of 6 to 14 mb/MeV sr^2, with half widths of 15 to 35 MeV. The corresponding polarizations were in the range from 0.14 to 0.32. (Diss. Abstr. Int., B)

39673 IMPROVED SIMULATION OF EXTENSIVE AIR SHOWERS WITH A MEDIUM-STRONG INTERACTION. Campbell, J. A. (Univ. of Texas, Austin). Phys. Rev., D; 5: No. 9, 2389-92 (1 May 1972).

An improved version of a previous simulation of extensive air showers above 10^{13} eV is discussed. In the simulation, the central assumption of a medium-strong contact interaction between protons is retained, but a model is used in which secondary pions are produced during pp collisions rather than through isobar decay. The influence of several different expressions for the multiplicity of pions and for the magnetic form factor of the proton is examined. While these expressions have noticeable quantitative effects on the behavior of the showers, the previous qualitative observation that the medium-strong interaction leads to a gradual increase in a measure of transverse momentum above a primary energy of 10^{14} eV is unchanged. (auth)

39674 DETERMINATION OF TRIPLE-REGGEON VERTICES FROM EXPERIMENT. Mickens, R. E. (Fisk Univ., Nashville); Rush, J. E. Jr. Phys. Rev., D; 5: No. 9, 2257-9(1 May 1972).

The exchange of an "effective" Regge trajectory is considered in the process $p + p \rightarrow p +$ anything, and estimates are obtained for the triple-Reggeon vertices. (auth)

39675 MODEL FOR THE PION-POMERANCHON REGGE CUT IN THE NEUTRON-PROTON CHARGE-EXCHANGE REACTION. Chia, Swee-ping (Univ. of Illinois, Urbana). Phys. Rev., D; 5: No. 9, 2316-27(1 May 1972).

A model is developed in which the pion-Pomeranchon Regge cut in the np charge-exchange reaction is calculated from the Mandelstam diagram. It is found that the Regge cut is self-conspiratory, and is determined by two parameters besides those associated with the pion pole and the Pomeranchon. The sharp forward peak is reproduced through the destructive interference between the pole and the cut. An excellent fit is obtained in the small-t region, and the values of the parameters producing this fit agree with physical intuition. (auth)

39676 INFINITE-ONE-BOSON-EXCHANGE TYPE MODEL FOR HIGH-ENERGY ELASTIC PROTON-PROTON SCATTERING. Kawasakai, Mamoru; Susuki, Yoshinori; Yonezawa, Minoru (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 589-602(Feb 1972).

For high-energy elastic proton–proton scattering an infinite one-boson-exchange (IOBE) type model is attempted as a generalization of the one-boson-exchange (OBE) model of strong interactions. Veneziano-like amplitudes are assumed for an infinite sum of one-particle-exchange amplitudes. It is shown that the coupling parameters required to reproduce experimental data at high energies $T_L = 5$ to 15 GeV are compatible with the corresponding ones of the OBE model obtained from low-energy analyses. (auth)

39677 MASSIVE LEPTON PAIR PRODUCTION IN HADRON COLLISIONS AND THE PARTON MODEL. Senju, Hirofumi (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 2, 724-5(Feb 1972).

A new parton model of elementary particles was previously proposed, which leads to a quartet model and in which nucleons and mesons are constructed from nine and six fundamental particles, respectively. The model is tested using cross section data for $p + p \rightarrow \mu^+ + \mu^- +$ anything. (L.B.S.)

39678 STAR PRODUCTION BY HIGH-ENERGY HADRONS. O'Brien, K. (Atomic Energy Commission, New York). Nucl. Instrum. Methods; 101: No. 3, 551-3(1972).

The production of nuclear stars resulting from the absorption of energetic hadrons in matter is almost proportional to the kinetic energy of the absorbed hadron. The value of the proportionality constant is obtained and its energy dependence discussed. (auth)

39679 ARGAND DIAGRAMS FOR THE QUASI-POTENTIAL AMPLITUDE OF pp AND $\bar{p}$p SCATTERING. Enkovskii, L. L.; Il'in, V. V.; Kobylinskii, N. A.; Tutik, R. S. (Inst. of Theoretical Physics, Kiev). JETP Lett. (USSR) (Engl. Transl.); 15: No. 5, 202-4(5 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 5, 288-90(5 Mar 1972).

Argand diagrams for quasipotential scattering amplitudes are used to describe data on pp and $\bar{p}$p scattering, taking into account the exchange of the pomeranchon and the Regge poles (P^1, ρ, ω, H_2). It is found that the model under consideration does not lead to the appearance of loops on the Argand diagrams for pp scattering. (L.B.S.)

39680 CROSSED-CHANNEL ANALYSIS OF AN INELASTIC SCATTERING PROCESS WITH THREE PARTICLES IN THE FINAL STATE. Karlukovski, V. I. God. Sofii. Univ., Fiz. Fak.; 62: 29-48(1967-68).

Use was made of the group-theoretical approach to the partial-wave analysis of the scattering amplitude so as to obtain the asymptotic behavior of the amplitude for a given class of inelastic processes with three particles in the final state. To be more precise a formalism of M. Toller, elaborated in detail by him for binary reactions, was used. The application of this formalism to the inelastic processes under review consists in their reduction to binary processes. Finally, with the aid of the results obtained for the asymptotic behavior of the amplitude an explanation is given for the experimental fact that in the inelastic scattering of protons on protons a comparatively great abundance of ω-mesons is produced, whereas there are absolutely or almost no data on the presence of ρ^0-mesons. (Abstr. Bulg. Sci. Lit., Math. Phys. Astron., Geophys., Geod.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 39714, 39737, and 40190.

39681 (ITF-71-133-P) ON THE CLEBSCH-GORDAN COEFFICIENTS OF GROUP SU(1,1). Gavrilik, A. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

Proceeding from the integral representation of Clebsch–Gordan coefficients for an arbitrary locally compact group, the exact formulas are obtained expressing the Clebsch–Gordan coefficients of group SU(1,1) with the participation of irreducible unitary representation of all series in terms of the generalized hypergeometric functions $_3F_2$ and $_yF_3$ of a unit argument. Some particular cases of the Clebsch–Gordan coefficients of a general expression, as well as their asymptotic behavior, are discussed. (auth)

39682 CLEBSCH-GORDAN COEFFICIENTS AND SPECIAL FUNCTION IDENTITIES. II. THE ROTATION AND LORENTZ GROUPS IN 3-SPACE. Miller, Willard Jr. (Univ. of Minnesota, Minneapolis). J. Math. Phys. (N. Y.); 13: No. 6, 827-33 (Jun 1972).

It is shown that the construction of concrete models of Clebsch–Gordan decompositions for tensor products of irreducible group representations leads to a wide variety of special function identities. The representation theory of the rotation and Lorentz groups in 3-space is used to give elegant derivations of identities involving Laguerre, Gegenbauer, hypergeometric, and generalized hypergeometric functions. Some of these identities may be new in this general form. (auth)

39683 SPECTRUM GENERATING ALGEBRAS AND SYMMETRIES IN MECHANICS. I. Hermann, Robert (Rutgers–The State Univ., New Brunswick, N. J.). J. Math. Phys. (N. Y.); 13: No. 6, 833-8(Jun 1972).

Certain differential-geometric and Lie group theoretic facts that are useful in the systematic study and search for spectrum generating algebras are presented. (auth)

39684 CALCULATION OF A CERTAIN TYPE OF 6j-SYMBOL. de Vries, E.; van Zanten, A. J. (Univ. of Groningen, Netherlands). J. Math. Phys. (N. Y.); 13: No. 6, 862-5(Jun 1972).

It is shown that, for an arbitrary finite simply reducible group, it is possible to express a certain type of 6j-symbol in which one of the representations is one-dimensional in terms of 3j-symbols $\{j\ k\ l\}$. (auth)

39685 HELICITY AND CANONICAL SPIN OPERATORS OF THE POINCARE ALGEBRA. Beckers, J. (Univ., Liege). J. Math. Phys. (N. Y.); 13: No. 6, 915-18(Jun 1972).

In the study of the irreducible unitary representations [m,s] of the Poincaré group, one defines an "helicity" spin operator through a fundamental connection between canonical and helicity bases. This operator, in covariant notation, is simply related to the well known Bargmann—Wigner operator and to the canonical spin operator. Its spatial components generate an SU(2)-algebra and coincide with the elements of the Z-spin algebra recently proposed on different grounds by Braathen—Foldy. The very simple arguments developed here establish in a natural way the uniqueness of this algebra when helicity representations are studied. (auth)

39686 NON-TRIVIAL COUPLING OF INTERNAL AND SPACE–TIME SYMMETRIES. Westenholz, C. v. (Univ., Muenster, Ger.). Int. J. Theor. Phys.; 5: No. 4, 275-89 (1972).

Previous results which exhibit the impossibility of combining internal and space-time symmetries are reanalyzed. Starting with McGlinn's (1964) work, where this trivial coupling appears as a direct product of these symmetries, it is shown that, by suitable generalizations such as the use of the framework of group extensions, and by the introduction of a new quantal observable, i.e., a "mass-breaking operator", the existence of a nontrivial coupling scheme can be proved which admits mass splitting for the members of some super-multiplet. This leads to a new classification scheme for elementary particles. Contrary to the conventional classification models, where the choice of the underlying symmetry group does not emerge directly from the comparison of theoretical predictions with the experimental data, the scheme admits the possibility of determining the relevant symmetry from the mass spectrum. (auth)

39687 WEYL BASIS OF THE UNITARY GROUP U(k). Seligman, T. H. (Univ. Nacional Autonoma de Mexico, Mexico City). J. Math. Phys. (N. Y.); 13: No. 6, 876-9(Jun 1972).

Weyl's method for the construction of irreducible tensors of the unitary group is used to construct a basis for any irreducible representation of U(k) or GL(k) in terms of Bose creation operators. A simple way is indicated to select a complete but not over complete basis from the functions obtained. The basis obtained can be useful in nuclear or molecular calculations, as well as in some mathematical problems. (auth)

39688 GROUP THEORY IN CLASSICAL AND QUANTUM PHYSICS. VOLUME 3. APPLICATIONS TO QUANTUM PHYSICS. Kahan, Theo (ed.). Paris; Dunod (1972). 288p. (In French).

Three applications of group theory to quantum physics and chemistry are presented: the Schroedinger equation and its symmetry properties (Wigner theorem); quantum physics of ions in crystals; vibrations in crystals: Raman scattering and infrared absorption. The first part only is indexed separately. (France)

For an abstract of an individual paper see: 40195.

Applications (Electromagnetic and Weak)

Refer also to abstract 39561.

39689 (COO–1112-39) INTERMEDIATE VECTOR BOSONS, SU(3) SYMMETRY AND CP VIOLATION. Tomozawa, Yukio (Michigan Univ., Ann Arbor). [nd]. 19p. Dep. NTIS.

A model with intermediate vector bosons, SU(3) symmetry and CP violation is described and helps to explain the Cabibbo angle, isospin selection rules, decay processes, and the CP violation in the $K^0 - \bar{K}^0$ system. For the W meson the coupling constant is found, and the order of magnitude of the lifetime for the processes $W \rightarrow K^- + \pi^+(K^+)$ and $W \rightarrow \pi^- + \pi^+$ is given. A way of detecting the W through the processes $p + p \rightarrow p + p + W$ and $\pi^- + p \rightarrow n + W$ is suggested. (J.F.P.)

39690 (DESY–72/19) SYMMETRIES AND THE $K_S \rightarrow \mu^+\mu^-$ BRANCHING RATIO. Dass, G. V. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1972. 28p. Dep. NTIS (U. S. Sales Only).

Implications of the low experimental $K_L \rightarrow \mu^+\mu^-$ decay rate, and of CP-, T- and CPT-invariances, for the $K_S \rightarrow \mu^+\mu^-$ branching ratio are considered. If virtual (energy nonconserving) transitions are allowed to be general, but the only "noninvariance" of physical (energy-conserving) transitions is in the feeble decay $K \rightarrow \mu^+\mu^-$, then, the lower bound on the $K_S \rightarrow \mu^+\mu^-$ branching ratio is 10^{-6} in the case of only T-invariance for $K \rightarrow \mu^+\mu^-$ amplitudes. [This bound gets worsened by a factor g (where present data allow $g \geq \frac{1}{4}$) if the mass-matrix parameters are taken from experiment, rather than being derived from the assumption of full (CP- and T- and CPT-)invariance for the $K \rightarrow \pi\pi$ amplitudes.] This is to be compared with the existing bounds of 10^{-6} for the corresponding case of only (full, also for virtual transitions) CPT-invariance, and zero for the corresponding case of only CP-invariance. Other less economical possibilities are also considered; in some of these cases also, there is no useful (nonzero) lower bound. (auth)

39691 INFINITE-COMPONENT WAVE EQUATIONS AND MASS SPLITTINGS WITHIN SU(3) AND SU(2) MULTIPLETS. Barut, A. O.; Monsma, William Brink (Univ. of Colorado, Boulder). Phys. Rev., D; 5: No. 9, 2327-31(1 May 1972).

Earlier work describing baryon excited states by the group O(4,2) is extended with particular emphasis on the SU(3) properties. A single irreducible representation of O(4,2) × SU(3) × SU(3) is used. The postulates of the theory of infinite-component wave equations are contrasted and compared with those leading to the Okubo and isospin mass-splitting formulas. Tables and curves are presented for mass formulas, mass splittings, and magnetic moments, which are in agreement with experiment. (auth)

39692 SYMMETRY BREAKING AND THE PIONIC DECAYS OF K MESONS. Goswami, D. N. (National Research Council of Canada, Ottawa); Schechter, J.; Ueda, Y. Phys. Rev., D; 5: No. 9, 2276-82(1 May 1972).

Symmetry-breaking corrections to the current-algebra formulas for $K \rightarrow 2\pi$ and $K \rightarrow 3\pi$ decays are calculated in the framework of a general form of the linear SU(3) σ model. (auth)

Applications (Strong)

39693 (BNL–16792) PRELIMINARY DESIGN OF LARGE ANGLE PROTON–PROTON ELASTIC SCATTERING FOR ISABELLE. Orear, Jay (Brookhaven National Lab., Upton, N. Y.). 28 Jul 1971. 4p. Dep. NTIS.

The experimental layout is described for $p + p \rightarrow p + p$ interactions at 30 GeV/c at large angles. The event rates for this experiment are calculated. (J.F.P.)

39694 (UH–511-100-71) FIELD-CURRENT IDENTITY, CP VIOLATION, AND NONCHIRAL SU(2) x SU(2) CLASSIFICATION OF HADRON STATES. Lee, Y. Y. (National Tsing Hua Univ., Hsinchu (Taiwan). Inst. of Physics); Tuan, S. F. (Hawaii Univ., Honolulu. Dept. of Physics and Astronomy). [1971]. 25p. (CONF-710816–8). Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Application of field-current identity to CP violating electromagnetic currents leads to C-exotic vector mesons and a consistent explanation of CP violation. Experimental implications and speculated connection with nonchiral SU(2) × SU(2) symmetry classification of states and the existence of C-parity Pais doublets are discussed. (auth)

39695 NEW OSCILLATOR ALGEBRA AND AN APPLICATION TO PARTICLE PHYSICS. Hieggelke, Curtis Jay. Lincoln, Neb.; Univ. of Nebraska (1971). 112p. University Microfilms Order No. 72-15,986.

Thesis.

An investigation is made of a family of representations of the Lie algebra of SO(3,2) and its relation to the three-dimensional nonrelativistic harmonic oscillator, the construction of a new relativistic algebraic analog of the nonrelativistic oscillator based on that family, and an application of this SO(3,2) relativistic oscillator to the quark model for mesons. It is found that the SO(3,2) relativistic oscillator possesses a very good nonrelativistic limit in the same sense as a previously known relativistic oscillator based on SU(3,1): The multiplet structure (which is that of the nonrelativistic oscillator) does not change in the limit, and the splitting between energy levels (determined from conservation of the electromagnetic current) approaches $\hbar\omega$ in the limit. In addition, the SO(3,2) oscillator is simpler; it has the minimum possible number of generators for such a model (10 vs 15), and it provides a physically reasonable mass spectrum more naturally. It is found that a quark model for mesons using the SO(3,2) oscillator to describe the orbital motion gives a reasonable account of the rates for decay to two pseudoscalar mesons, provided the composite nature of both outgoing mesons is taken into account. (Diss. Abstr. Int., B)

39696 ASYMPTOTIC ALGEBRAIC REALIZATION OF SU(3), BARYON CLASSIFICATION, $g_A(0)$, AND D/F RATIO. Oneda, S. (Univ. of Maryland, College Park); Matsuda, Seisaku. Phys. Rev., D; 5: No. 9, 2287-9(1 May 1972).

In the framework of the chiral SU(3) ⊗ SU(3) charge algebra and asymptotic SU(3), a scheme of asymptotic algebraic realization of SU(3) is proposed. For the axial-vector couplings, it yields $D/F = \frac{3}{2}$ but $g_A(0) = \frac{5}{3}\sqrt{f}$, f being the universal fractional contribution ($\approx 50\%$) to the sum rules coming from the ground-state baryons. Neither the assumption of saturation by low-lying states nor the introduction of large configuration mixing is necessary. (auth)

39697 SIX-DIMENSIONAL FORMULATION OF MESON EQUATIONS. Lord, Eric A. (Inst. of Mathematical Sciences, Madras). Int. J. Theor. Phys.; 5: No. 5, 339-48(1972).

The structure of the conformal group is studied by a generalization of quaternion methods to six dimensions. Some simple SO(4,2) covariant equations are shown to correspond to the Kemmer formulation for pseudoscalar and vector mesons, and the matrix elements of the irreducible representations of the Kemmer algebra are expressed as traces of products of Dirac matrices. (auth)

39698 TOTAL SCATTERING CROSS SECTIONS IN TWO-BODY STRONG INTERACTIONS CALCULATED BY AN ALGEBRAIC APPROACH USING THE GROUP SU(1,3). Kalman, C. S. (Loyola Coll., Montreal). Can. J. Phys.; 50: No. 5, 481-99 (1 Mar 1972).

A method is developed for the calculation of total scattering cross sections in two-body strong interactions by an algebraic approach using the group SU(1,3). A general discussion of the method, its historical development, and a possible theoretical basis is presented. Total cross sections for a total of 95 events based on 8 parameters are predicted. Only 19 of these cross sections were experimentally measured. Of these, 7 consist of only 1 experimental measurement and so cannot be used. The remaining cases are sufficient only to show that the predictions seem to be of the correct order of magnitude. (auth)

Field Theories

General

Refer also to abstract 38542.

39699 (JINR—E2-6398) EQUAL-TIME CANONICAL COMMUTATION RELATIONS AND PERTURBATION THEORY. Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 6p. Dep. NTIS (U. S. Sales Only).

The breakdown of equal-time canonical commutation relations in perturbation theory is proved. (auth)

Quantum Field Theory

Refer also to abstracts 39346, 39595, and 39744.

39700 (ITF—71-90-P) ON THE SOLVABILITY OF EQUATIONS FOR THE GREEN FUNCTIONS OF EUCLIDEAN THEORY OF FIELD. Gonchar, N. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 43p. (In Russian). Dep. NTIS (U. S. Sales Only).

The solvability of the generalized Schwinger equations for the Green functions of the Euclidean field theory is investigated for the case of interaction $[Y(x)]^{Zm}$, where Y(x) is the scalar field with mass $\mu > O$. The solvability of the generalized Schwinger equations is proved for the Green functions of the Euclidean field theory, and the representation in terms of a functional integral is found for the solution. A random field $\xi(x)$ is constructed, so that the solution is representable in the form $\{S(x_1,x_2\ldots,x_n) = \int_\Omega \xi(x_1)\ldots\xi(x_n)dP_1\}_{n=0}^{\infty}$ where P_1 is the probability measure on a functional space Ω. (auth)

39701 (ITF—71-91-P) RENORMALIZATION GROUP AND ANOMALOUS DIMENSIONS. Kovalenko, V. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The Callan—Symanzik equations describing the violation of the scaler invariance in quantum electrodynamics in the limit $m^2 \to O$ are investigated by means of renormalization group. Expressions for the canonical and anomalous dimensions of the spinor and electromagnetic fields are obtained while studying the conditions which are necessary to fulfil the scale invariance. (auth)

39702 (ITF—71-98-E) WIGNER—ECKART THEOREM AND COVARIANT OPERATORS. I. Klimyk, A. U. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 48p. Dep. NTIS (U. S. Sales Only).

Matrix elements of the operators invariant under the group and depending on the functions of Schwartz space (operators such as the scalar field operators) are studied. It is proved that the matrix elements of such operators are factorized in a weak sense into the Clebsch—Gordan coefficients of the group and reduced matrix elements depending on a smaller number of variables. (auth)

39703 (ITF—71-104-P) EVOLUTION OF THE PHYSICAL PICTURE OF THE WORLD. I. Akhiezer, A. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 33p. (In Russian). Dep. NTIS (U. S. Sales Only).

A systematic review is given of the ideas that constitute the basis for the development of physics. The gnosiological problems bound up with the development of theoretical physics are discussed together with the physical ideas. The first part of the review is devoted to a discussion of the principles of classical mechanics, classical electrodynamics and relativity theory. The second part presents the foundations of quantum mechanics, including the problems of the theory of measurements, the principles and results of quantum electrodynamics and the general ideas of elementary particle physics. The review is concluded with the discussion of the relations between the theoretical physics and mathematics, as well as the connection of the theoretical physics with experimental one. (auth)

39704 (ITF—71-129-P) ON SIMULTANEITY NOTION IN THE SPECIAL RELATIVITY. Ganaga, V. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

An instance of a nonstandard (Newtonian) synchronization of the clock, allowing the Newtonian simultaneity to be introduced into special relativity, is considered. Such a synchronization can be carried out from one inertial frame of reference where n identical Einstein-synchronized clocks are available in another frame where η' identical clocks are to be started. It is mentioned that the introduction of the Newtonian simultaneity into special relativity leads inevitably to the idea about a singled-out frame of reference (T_0). The transformations of coordinates, time and velocities while carrying out the Newtonian synchronization of the clocks from the frame T_0 in any frame of reference moving steadily with respect to the former are presented. It is shown that this approach does not contradict the relativity principle. It is conjectured that the frame T_0 may represent a frame of reference with respect to which the background radiation is isotropic. The possibilities of giving an experimental proof to such a conjecture and determining the rate of motion of the solar system with respect to the frame T_0 are discussed. (auth)

39705 (JINR—P2-6351) QUANTIZATION OF THE SPINOR FIELD IN SPHERICAL SPACE—TIME. Chernikov, N. A.; Shavokhina, N. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

The Dirac equation in spherical space-time is solved using separation of variables. A complete countable set of the creation and annihilation operators of electrons and positrons is obtained. The property of being countable is due to the compactness of the spherical space. The operators of the most important physical quantities are constructed. (auth)

39706 (JINR—P2-6384) ON THE EQUIVALENCE THEOREM IN QUANTUM FIELD THEORY. Efimov, G. V.; Rutenberg, M. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

A regularization procedure is introduced in the framework of standard methods in quantum field theory. It provides the equality of the S-matrix corresponding to the interaction Lagrangians which are connected by a local transformation of field variables. (auth)

39707 ULTRALOCAL QUANTUM FIELD THEORY IN TERMS OF CURRENTS. Newman, Charles Michael. Princeton, N. J.; Princeton Univ. (1971). 145p. University Microfilms Order No. 72-14,160.

Thesis.

Ultralocal field theories, whose Hamiltonians contain an interaction term but no gradient terms and are therefore diagonal in position space, are studied in a mathematically rigorous manner. It is proposed that such ultralocal Hamiltonians be used as the zeroth-order approximation in an alternate approach to constructive quantum field theory. It is shown that, except for the free case (no interaction term), ultralocal theories cannot be constructed in terms of canonical fields satisfying the canonical commutation relations in any natural way. Two currents, defined heuristically in terms of canonical fields, are therefore used as the basic dynamical variables of these theories with a simple equal time current algebra replacing the canonical commutation relations. The Hamiltonian is then heuristically defined in terms of these two currents and it is shown that in the free case, the Hamiltonian density current together with the two basic currents determine a current algebra related to the group, SL(2,R). (TSS)

39708 NUMERICAL CALCULATION OF INCLUSIVE SPECTRA AND CORRELATIONS IN A φ LADDER MODEL. Bopp, Fritz W. (Univ. of Illinois, Urbana). Phys. Rev., D; 5: No. 9, 2297-2305(1 May 1972).

A numerical calculation is presented of the inclusive one- and two-particle spectra and the two-particle correlation function at several energies for ladder diagrams in a $\lambda\varphi^3$ field theory. (auth)

39709 ANALOG OF MAGNETIC MONOPOLE IN A GENERAL GAUGE FIELD. Murai, Nobuyuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 678-92(Feb 1972).

The concept of an analog of magnetic charge is introduced into the Yang–Mills field by reference to local singularities of the classical field. On the basis of the gauge-invariant and path-dependent formalism, the one-valuedness of the path-dependent quantities for a scalar field interacting with the Yang–Mills field imposes a quantum condition on the coupling constant. When the Yang–Mills field is analytic in spacetime, this property leads to consistency conditions analogous to the homogeneous Maxwell equations and to Bianchi identities in the theory of the general relativity. A simple example with a non-trivial (non-zero quantum number) quantum condition is presented in a way compatible with the framework of nonrelativistic quantum mechanics, where the Yang–Mills field works on the scalar field as an external field. Additional remarks on more general gauge fields are appended. (auth)

39710 REPRESENTATION OF SYMMETRIES AND OBSERVABLES IN FUNCTIONAL HILBERT SPACE. II. Rieckers, A. (Univ., Tuebingen, Ger.). Z. Naturforsch.; 27a: No. 1, 7-22(Jan 1972).

The representation of infinitesimal generators corresponding to the group representation discussed previously is analyzed in the Hilbert space of functionals over real test functions. Explicit expressions for these unbounded operators are constructed by means of the functional derivative and by canonical operator pairs on dense domains. The behavior under certain basis transformations is investigated, also for non-Hermitian generators. For the Hermitian ones a common, dense domain is set up where they are essentially self-adjoint. After having established a one-to-one correspondence between the real test function space and a complex Hilbert space the theory of quantum observables is applied to the functional version of a relativistic quantum field theory. (auth)

39711 AXIOMATIC FOUNDATIONS OF THE THEORY OF SPECIAL RELATIVITY. Stiegler, Karl (Technical Univ., Munich). Int. J. Theor. Phys.; 5: No. 6, 403-19(1972).

It is shown that (1) linear transformations more general than the Lorentz transformation — containing the Palacios and the Lorentz transformation as special cases — (2) and the "principle" of the constancy of the velocity of light (taken originally by Einstein together with the supposition of the linearity of transformation as fundamental hypotheses of the theory of special relativity) — can be deduced from Maxwell's equations for the electromagnetic field in vacuo (A_1), the principle of relativity (A_2) and the two following axioms: (A_3) to every event in the Galilean reference system S there corresponds one and only one event in the system S′ so that these two systems are connected by reversible single-valued functions, continuously differentiable as their inverse transformations, (A_4) the constant relative velocities $v_{ss'}$ and $v_{s's}$ between S and S′ are each other equal in magnitude and opposite in sign $v_{ss'} = -v_{s's}$. To obtain uniquely the Lorentz transformation the following axiom has to be added: (A_5) the distance D of any two points at rest in S, situated in a plane orthogonal to the relative velocity between S and S′ is measured S′ as independent of the sense of the velocity, i.e., if one changes $v_{ss'}$ into $-v_{ss'}$ the distance D does not vary for an observer in S′. Results of the theory are the ideas that (a) the fact that the Lorentz transformation is not the unique transformation leaving Maxwell's equations for the electromagnetic field in all Galilean systems of reference invariant but that there exists a more general transformation (containing these two transformations as special cases) leaving Maxwell's equations invariant; (b) that the Michelson–Morley as well as the Fizeau experiment does not represent an experimental proof in favor of the theory of special relativity. The mutual relations between the principle of relativity (the axiom A_1 together with the axiom A_2), the axiom A_5 and the possibility of the discernibility as well as the indiscernibility of "right" and "left" at the macrocosmic level are discussed. (auth)

39712 GARDING DOMAINS AND ANALYTIC VECTORS FOR QUANTUM FIELDS. Hegerfeldt, Gerhard C. (Univ., Goettingen, Ger.). J. Math. Phys. (N. Y.); 13: No. 6, 821-7(Jun 1972).

If one studies the canonical commutation relations (CCR's) of quantum field theory in the unitary Weyl form, one does not know if one can find a common dense domain for the field operators since their domain of definition depends on the test function. A general class of test function spaces including the spaces S and D of Schwartz and the space $V_0 \simeq R^{(\infty)}$ of all finite linear combinations of a countable basis is considered. It is shown that there exists an invariant Garding domain D on which all fields are defined and strongly continuous. D consists of analytic vectors for the fields. It turns out that the test function space can be enlarged by continuity. For irreducible or factor representations it becomes even a Hilbert space. The basic idea of the proof is the same as in the Schrödinger representation for one degree of freedom and very transparent. One simply uses rapidly decreasing functions in "Q-space" and "P-space" as smoothing factors. That this can be done in the infinite case also is due to a new and interesting measure theoretic result derived here. As an application of the results it is mentioned that the renormalized fields (after removing the cutoff) of the Φ_2^{2n} model of Glimm and Jaffe possess a Garding domain for test functions in S or D for each time. (auth)

39713 TOPOLOGICAL ANALYSIS OF SELF-GENERATING INTERACTIONS IN LAGRANGIAN FIELD THEORY. Gunzig, E. (Univ. Libre, Brussells). J. Math. Phys. (N. Y.); 13: No. 6, 850-62(Jun 1972).

The n-body nonlocal potentials, parameters of a given Lagrangian field theory are determined entirely, in terms of a set of independent functionals of the many-body propagators. These functionals are more suitable for the description of self-generating interactions than the many-body propagators themselves. (auth)

39714 CONSTRUCTING EXAMPLES IN RELATIVISTIC CLASSICAL PARTICLE MECHANICS. Shukre, C. S. (Univ. of Pittsburgh); Jordan, T. F. J. Math. Phys. (N. Y.); 13: No. 6, 868-71 (Jun 1972).

A new method is proposed for constructing examples in relativistic classical particle mechanics, starting with the Poincaré group and space reflections as transformations of position and velocity variables for two free particles and deriving equations for Lorentz covariant position variables for two interacting particles. The advantages are that the equations do not couple the position variables of the two particles, and solutions yield the particle world lines directly. Solutions are obtained for a special case. (auth)

39715 RENORMALIZATION OF THE HILBERT SPACE IN THE MASS SHIFT MODEL. Rosen, Lon (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 13: No. 6, 918-27(Jun 1972).

The $(\phi^2)_{s+1}$ quantum field theory model can be solved exactly, where the number of space dimensions is $s \leq 3$. Thus this model explicitly illustrates many properties of nontrivial models such as $(\phi^{2n})_2$ and Yukawa$_2$. In particular hyperbolicity, the energy spectrum, local Fockness, and the change of Hilbert space as the spatial cut off is removed are studied. (auth)

39716 SECOND QUANTIZED MODEL OF ANHARMONICITY. Rasetti, Mario (Univ. of Miami, Coral Gables, Fla.). Int. J. Theor. Phys.; 5: No. 6, 377-89(1972).

The transition probabilities of a model arbitrarily driven harmonic oscillator are calculated, in a formalism which suggests the general description of anharmonicity in second-quantized way, by means of generalized fields representing complex excitations: "clusters" of a finite number of particles, weakly interacting — at lower order — with the particles themselves and with other excitations. (auth)

39717 EXACTLY SOLUBLE MODELS FOR INTERACTING VECTOR AND SCALAR FIELDS. Horvath, Z. (Roland Eoetvoes Univ., Budapest). Acta Phys. Austr.; 34: No. 1-2, 93-101(1971).

In exactly soluble field theoretic models for generalized scalar and vector fields the following problems are studied: derivative couplings, asymptotic condition, validity of mass-squared sum rules, 'PCAC", symmetry and symmetry-breaking in bare and real fields, respectively. (auth)

39718 RENORMALIZATION, FORMAL PERTURBATION THEORY, AND DEGENERATE POTENTIALS. Gruemm, Hans-Richard (Univ., Vienna). Acta Phys. Austr.; 34: No. 1-2, 133-61(1971). (In German).

A simple quantum-mechanical model with nontrivial renormalization is studied by means of perturbation theory. It is shown that the usual method does not lead to the correct results in this case. By partial summation a renormalized perturbation series is defined whose convergence to the correct result is shown. (auth)

39719 VACUUM POLARIZATION IN STRONG INHOMOGENEOUS FIELDS. Migdal, A. B. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1621-38(May 1972). (In Russian).

It is shown that in strong fields the motion of particles is characterized by a correlation radius R_c which is related to the field strength E(r) by the formula $R_c^2(r) = 1/eE(r)$. In sufficiently strong fields R_c is much less than the length over which the field varies. The field therefore may be regarded as homogeneous even at small distances from a Coulomb center. This localizability property permits one to determine the dielectric permeability of vacuum and the polarization charge distribution near an external charge of arbitrarily small radius R_0. A relation between the true charge Z_0 and observed charge Z is derived. It is demonstrated that for a given Z the charge Z_0 remains finite for $R_0 \to 0$. A possible mechanism of removing electrodynamic divergences is discussed. (auth)

Gravitation and General Relativity

Refer also to abstracts 39359, 39621, and 39658.

39720 EQUATIONS OF MOTION IN ASYMPTOTICALLY FLAT EMPTY SPACES. Messmer, James Robert. Pittsburgh; Univ. of Pittsburgh (1971). 92p. University Microfilms Order No. 72-16,138.

Thesis.

A new approach to equations of motion is presented in which the spin coefficient formalism of Newman and Penrose is used. Through the use of coordinate conditions different from the Bondi type and with the aid of techniques that arise from the theory of representations of the Lorentz group, equations of motion in asymptotically flat spaces are obtained. As an important result, a gravitational "radiation-reaction" term analogous to the Abraham "radiation-reaction" term of electrodynamics is discovered. (Diss. Abstr. Int., B)

39721 GRAVITATIONAL WAVES OF SECOND ORDER IN EMPTY SPACE. Tokuoka, Tasuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 693-702(Feb 1972).

The gravitational waves of second order in empty space with any gravitational field are investigated theoretically by the method of characteristics. A ten-dimensional space T_{10} is introduced and the propagation condition is resolved in T_{10} representation. Three kinds of waves, transverse, longitudinal and shear, are derived formally. It is proved that real waves are transverse, and longitudinal and shear waves can be canceled out by appropriate coordinate transformations. (auth)

39722 GRAVITATIONAL WAVES OF SECOND ORDER FOR SCALAR-TENSOR FIELD. Tokuoka, Tatsuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 703-7(Feb 1972).

Gravitational waves of second order for Brans and Dicke's scalar-tensor field theory with any field strength are investigated by the method of characteristics. An eleven-dimensional isometric space T_{11} with space-time is introduced and the propagation conditions are analyzed in this representation. Only the transverse wave is real and it has three independent components. Whether the trace of the transverse components of the wave amplitude vanishes or not depends on whether it is a wave of a pure tensor field or a scalar-tensor field respectively. (auth)

39723 INTERACTION OF ZERO-MASS MESON AND CHARGED DUST IN AXIALLY SYMMETRIC FIELDS. Misra, R. M.; Pandey, Deo Bhushan (Univ. of Gorakhpur, India). Ann. Phys. (N. Y.); 71: No. 1, 293-300(May 1972).

A family of axially symmetric stationary solutions of the field equations of general relativity with charged incoherent matter and zero-mass scalar meson field as source are investigated. The charged dust is in rigid rotation and the Lorentz force vanishes everywhere. The interesting feature of the solution is that the ratio of matter and charge densities may assume arbitrary values. It is further found that the presence of massless meson field acts, speaking not quite correctly, as an attractive potential near the axis and concentrates the matter and charge to infinite values of their densities. (auth)

39724 SCALAR FIELD THEORY OF GRAVITATION. Linden, T. L. J. (European Space Research Organisation, Darmstadt, Ger.). Int. J. Theor. Phys.; 5: No. 5, 359-68(1972).

A scalar theory of gravitation is developed from a variational principle. The speed of light is taken to be a function of the potential of the gravitational field. The predictions of the light deflection and the advancement of the perihelion agree with those made by Einstein's theory. The gravitational (active) mass differs from the inertial (passive) mass and both are dependent on the gravitational potential. (auth)

39725 CLOCK PARADOX IN THE RELATIVITY THEORY. Wu, Ta-you; Lee, Y. C. (State Univ. of New York, Buffalo). Int. J. Theor. Phys.; 5: No. 5, 307-23(1972).

A system S′ (rocket) starts from rest in an inertial system S and after a series of accelerated, uniform and decelerated motions, comes back to rest at its initial position in S. An exact calculation is carried out, from the standpoint of S, of the time intervals for the arrivals at S of light signals sent back by S′. From the standpoint of S′, S has made a round trip after undergoing a series of free falls in gravitational fields and coasting motions. An exact calculation is carried out for the "proper time" intervals in S from the standpoint of S′. It is shown that there is exact agreement between S and S′ in their reckonings of the total time intervals for the two frames, namely, both S and S′ agree quantitatively, to them, the time interval is longer for S than for S′. The accelerated motion of S′ relative to S explicitly used in the treatment of the problem is that under time-independent field and subject to the condition of local Lorentz contraction and dilation the resulting motion turns out to be that obtained earlier by Møller on entirely different considerations. The result of the present treatment is, however, more general than this particular motion seems to imply, since by an arbitrary coordinate transformation, it can be made to include an infinite number of accelerated frames including time-dependent fields, all within the framework of flat space-time. General remarks are given for the clock problem in the general theory of relativity in the sense of Einstein's curved space. (auth)

39726 CLASSIFICATION OF DISPLACEMENTS AND ROTATIONS IN A CELLULAR SPACE-TIME. Cole, E. A. B. (Univ. of Leeds, Eng.). Int. J. Theor. Phys.; 5: No. 6, 437-46(1972).

The implications of the lack of continuity in space-time brought about by every observation process are discussed in connection with the need for finding new observables based on realizable measuring processes. Displacements in a cellular space are defined and their rules of combination are formulated. Rotations in a cellular space are defined in terms of a set of radius displacements and in terms of a set of instructions which tell how these radii should be used. (auth)

39727 ALGEBRAIC PROPERTIES OF RELATIVISTIC EQUATIONS FOR ZERO REST-MASS. Lord, Eric A. (Inst. of Mathematical Sciences, Madras). Int. J. Theor. Phys.; 5: No. 5, 349-57(1972).

Some algebraic properties of the generalized Pauli matrices of Barut, Muzinich and Williams are derived and used to demonstrate the equivalence of the zero-mass equations of Nelson and Good with those of Dirac, Fierz and Pauli. The conserved rank four tensor of the spin-2 theory is shown to have the structure of Bel's tensor for a gravitational field satisfying Einstein's empty space equations, in the linearized version of general relativity. (auth)

39728 NEUTRINO RADIATION FIELDS IN GENERAL RELATIVITY. Collinson, C. D.; Morris, P. B. (Univ. of Hull, Eng.). Int. J. Theor. Phys.; 5: No. 5, 293-301(1972).

All space-times admitting a neutrino radiation field are obtained. Three classes of such space-times exist, characterized by the Weyl tensor being of type D, N (or O) or III. (auth)

39729 CONTRIBUTION TO THE RAINICH THEORY OF THE NEUTRINO FIELD. Griffiths, J. B. (Univ. of Tech., Loughborough, Eng.); Newing, R. A. Int. J. Theor. Phys.; 5: No. 6, 421-7(1972).

The neutrino-gravitational field is divided into fourteen distinct classes. This classification is shown also to determine the class of the space-time. Then for four particular classes of space-time, necessary and sufficient conditions on the concomitants of the Ricci tensor are given for it to admit a neutrino field. It is further shown that for three of these classes the neutrino field is determined uniquely by the metric of space-time. (auth)

39730 POSSIBLE VARIATION OF THE GRAVITATIONAL CONSTANT OVER THE ELEMENTS. Gilvarry, J. J.; Muller, P. M. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 28: No. 25, 1665-9(19 Jun 1972).

The theory and data of the Kreuzer experiment are re-examined to measure the relative difference $\Delta\kappa/\kappa$ in the gravitational constant κ between two elements. Significant errors appear in the statistical analysis of Kreuzer which vitiate his conclusions. The upper bound for F and Br from his experimental data correctly becomes $(\Delta\kappa/\kappa)_{\max} = 2 \times 10^{-2}$, about 10 times the limit already set on the general variation of κ over the elements by direct use of a Cavendish balance. (auth)

39731 FOUR-DIMENSIONALITY OF SPACE AND THE EINSTEIN TENSOR. Lovelock, David (Univ. of Waterloo, Ont.). J. Math. Phys. (N. Y.); 13: No. 6, 874-6(Jun 1972).

All tensors of contravariant valency two, which are divergence free on one index and which are concomitants of the metric tensor, together with its first two derivatives, are constructed in the four-dimensional case. The Einstein and metric tensors are the only possibilities. (auth)

39732 INTERACTION BETWEEN WEAK GRAVITATIONAL WAVES AND A GAS. Polnarev, A. G. Zh. Eksp. Teor. Fiz.; 62: No. 5, 1598-1605(May 1972). (In Russian).

Interaction between a weak gravitational wave (G.W.) and a gas is considered. The problem is solved for a plane Minkowski space–time. It is shown that if prior to traversal of the G. W. the distribution function of the gas f_0 was isotropic, then the phase velocity $v_p > c$. Anisotropy of f_0 may lead to $v_p < c$. In this connection the interaction of a G. W. and a beam of ultrarelativistic particles is considered. It is proven that in a collisionless gas there is no specific attenuation of G. W. similar to Landau attenuation of waves in a plasma. The complex refractive index for G. W. in a gas is calculated by taking into account collisions. For comparison collisionless interaction between shortwave adiabatic perturbations of the metric at early stages of expansion of the universe with a neutrino gas is considered. It is shown that in contrast to G. W., damping of adiabatic perturbations is possible which is analogous to Landau damping. The condition is derived for which sufficiently strong anisotropy of the neutrino f_0 results in collisionless damping of adiabatic perturbations being replaced by their amplification. (auth)

39733 GENERAL COSMOLOGICAL SOLUTION OF THE EINSTEIN EQUATIONS WITH A TIME SINGULARITY. Belinskii, V. A.; Lifshits, E. M.; Khalatnikov, I. M. (Inst. of Physical Problems, Moscow. Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1606-13(May 1972). (In Russian).

It is shown how change of Kasner epochs under oscillatory conditions of approach to a singularity may be described in the general (inhomogeneous) solution of the Einstein equations. The universality of the law of alteration of the Kasner indexes previously established (for homogeneous models) is proven and a general description of Kasner axis rotations during changes of epochs is presented. This completes the proof of the existence of a general solution with a time singularity. (auth)

39734 DYNAMIC CHARACTERISTICS OF A SYSTEM IN THE TETRAD FORMULATION OF THE THEORY OF RELATIVITY. Syaglo, I. S. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 89-94 (1971). (In Russian).

Components of Ricci rotation coefficients (invariant, relatively local, three-dimensional rotation of reference triads) were introduced into the tetrad formulation of the theory of relativity. They are clearly isolated in the tetrad equation of Einstein gravity. This reveals that the Einstein equations in chronometric-invariant form are a simplified record of tetrad equations. The appropriateness of the entry of calibrated conditions is discussed for a tetrad through the dynamic characteristics of the system. (tr-auth)

39735 HEISENBERG EQUATIONS OF MOTION FOR SPIN-$\frac{1}{2}$ WAVE EQUATION IN GENERAL RELATIVITY. Wong, S. K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Int. J. Theor. Phys.; 5: No. 4, 221-30(1972).

The Heisenberg equations of motion for the spin-$\frac{1}{2}$ wave equation in general relativity are obtained by a covariant procedure. They are found to be similar to the equations of motion for a classical pole-dipole test-particle in general relativity. The identification is complete when the Heisenberg equations are taken to be satisfied by the respective expectation values. (auth)

39736 STATIC BODY OF ARBITRARILY LARGE DENSITY. Bonnor, W. B.; Wickramasuriya, S. B. P. (Queen Elizabeth Coll., London). Int. J. Theor. Phys.; 5: No. 6, 371-5(1972).

The static, spherically symmetric, perfect fluid solution is considered for a given mass m in general relativity, and it is shown that its average density is bounded. By an example it is shown that this need not be so for nonspherical bodies. (auth)

39737 GAUGE VARIANCE OF ACTION FUNCTIONS UNDER TRANSFORMATIONS ON SPACE-TIME. Whiston, G. S. (Univ., Naples). Int. J. Theor. Phys.; 5: No. 6, 391-401(1972).

The problem of the gauge variance or invariance of action functions in classical mechanics is discussed from a group and path-theoretic viewpoint. By using the elementary theory of the cohomology of groups, criteria are introduced which enable one to decide when action functions gauge variant under a kinematical group are equivalent to action functions invariant under the transformations of the group. The criteria are applied to action functions gauge variant under Lorentz and Galilei transformations, where it is deduced that any action function gauge variant under the Lorentz group is equivalent to an action function invariant under Lorentz transformations, whilst action functions gauge variant under the Galilei group are not necessarily equivalent to Galilei-invariant action functions. It is also shown that any action function gauge variant in a more restricted fashion, which is defined in the text, is necessarily equivalent to a "kinetic-energy" action. (auth)

39738 FURTHER REMARKS ON A THEORY OF EXTENDED QUANTIZATION. Crocker, Roger (John Carroll Univ., Cleveland). Int. J. Theor. Phys.; 5: No. 5, 303-5(1972).

The quantity of mass-energy in the universe is expressed in terms of some of its basic parameters. The methods of derivation involve the minimum possible unit of energy and the minimum possible nonzero force, introduced in (Crocker, 1970). (auth)

Scattering Theory

Refer also to abstracts 39547 and 39590.

39739 (COO-1764-147) TWIST RELATION, THIRD FACTORIZATION AND THE GENERAL VERTEX IN A DUAL MULTIPARTICLE THEORY WITH NONLINEAR TRAJECTORIES. Baker, M.; Yu, S. (Washington Univ., Seattle); Coon, D. D. (Pittsburgh Univ., Pa.). [1971]. Contract AT(45-1)-1388. 35p. (RLO-1388-627). Dep. NTIS.

The following properties of the dual multiparticle theory with nonlinear trajectories are presented: the twist relation, the unsymmetric general vertex obtained directly from third factorization, and the symmetric general vertex. (auth)

39740 PHASE PROBLEM AND THE SIGNATURE RULE IN MULTIPLE-SCATTERING REGGE CUTS. O'Donovan, Patrick J. (Arizona State Univ., Tempe). Phys. Rev., D; 5: No. 9, 2290-6 (1 May 1972).

It is often stated that a double-Regge-pole-exchange amplitude has definite signature which is given by the product of the signatures of the exchanged poles. This signature rule places severe restrictions on any model which generates Regge cuts from the nonlinear direct-channel unitarity relation. With the intermediate-state particles treated as composite rather than elementary, however, the signature rule no longer follows. The phase of a double-exchange amplitude is found to be the same as in the simplified treatment (i.e., a simple function of the exchanged trajectories) while the s dependence follows from the details of the spectra and coupling of the intermediate-state particles. It is suggested that multiple-scattering models should be considered as unitarity-generated approximations in which s–u crossing is viewed as a constraint on the couplings and spectra of the intermediate states and not as a constraint on the signatures of the exchanged Regge poles. Phenomenological consequences are discussed. (auth)

39741 ASYMPTOTIC BOUNDS ON THE ABSORPTIVE PARTS OF THE ELASTIC SCATTERING AMPLITUDES. Singh, Virendra (Rockefeller Univ., New York); Vengurlekar, A. S. Phys. Rev., D; 5: No. 9, 2310-15(1 May 1972).

Exact bounds on the absorptive parts A(s,t) of an elastic scattering amplitude (spinless case) are established and are evaluated for positive t values lying within the Lehmann–Martin ellipse [the major axis $= 2(1 + t_0/2k^2)$]. These bounds are used to derive a number of asymptotic results; e.g., (i) the "diffraction-peak width" W is larger than $W_{min} \sim 4t_0/(1 + \lambda)^2 \times (1 - \frac{1}{2}\sigma)(\ln s)^2$ (for $s \to \infty$); (ii) the leading Regge trajectory for $t_0 > t > 0$ lies below $[1 + (t/t_0)^{\frac{1}{2}}] - \lambda[1 - (t/t_0)^{\frac{1}{2}}]$; (iii) there are no complex zeros of A(s,t) for $|t| < 4t_0/(1 + \lambda)^2 e^2(\ln s)^2$ (for $s \to \infty$) and no real zeros for $t_0 > t > -W_{min}$, where $\lambda = \lim_{s\to\infty} \ln\sigma_{tot}(s)/\ln s$ and $\sigma = \lim_{s\to\infty} t_0\sigma_{tot}(s)/4\pi(\ln s)^2$. (auth)

39742 FIXED AND MOVING POLES IN THE VIRASORO MODEL ARE MULTIPLICATIVE. Oh, C. H. (Univ. of Otago, Dunedin, N. Z.). Progr. Theor. Phys. (Kyoto); 47: No. 2, 710-12(Feb 1972).

Analyses of the angular momentum l-plane structure of the Virasoro model have shown that the Virasoro partial-wave amplitude $\alpha(l,s)$ has fixed poles at $l = -2n-1$ and moving poles at $l = +\alpha(s)-2n$ where n is any non-negative integer. It is shown that Kawai's argument (Prog. Theor. Phys. 45: 1578(1971)) that these poles are additive is incorrect and that his discussion on unitarity connected with the fixed poles is not valid. It is concluded that the fixed and moving poles occur multiplicatively. (L.B.S.)

39743 SINGLE-PARTICLE RESONANCES AND KAPUR–PEIERLS THEORY. Dubois, D. M.; Nagarajan, M. A. (Univ., Liege). Bull. Soc. Roy. Sci. Liege; 40: No. 5-8, 262-70(1971).

The correspondence between scattering resonances and Kapur–Peierls eigenstates is studied in the case of S- and P-wave scattering by a square well potential. The Kapur–Peierls eigenstates are known to yield the exact bound states and they are found to yield extremely good eigenvalues for resonances below potential barrier. It is shown that a unitarized one-level approximation to the S-matrix yields a very good fit to the exact scattering cross section. The case of "threshold" resonance in S-wave scattering is also investigated. It is seen that the correspondence between

Kapur–Peierls eigenstates and the R-matrix eigenstates holds over the considerable energy range close to zero energy, indicating that a perturbation expansion of the Kapur–Peierls eigenstates in terms of the R-matrix states is meaningful. An alternate method of expanding the Green's function in terms of Kapur–Peierls eigenstates is also studied. It is shown that the Green's function method yields a very poor prediction because the background phase shift it predicts is wrong. (auth)

39744 THREE-DIMENSIONAL FORMULATION OF THE RELATIVISTIC TWO-BODY PROBLEM. Kadyshevskii, V. G.; Mir-Kasimov, R. M.; Skachkov, N. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Probl. Fiz. Elem. Chastits At. Yadra; 2: No. 3, 635-90(1972). (In Russian).

A quasipotential approach to the relativistic two-body problem is developed in the framework of the three-dimensional Hamiltonian formulation of the quantum field theory. On the base of the expansion in matrix elements of irreducible unitary representations of the Lorentz group the relativistic configuration representation is introduced and studied. A representation for the quasipotential scattering amplitude at high energies, generalizing the nonrelativistic eikonal formula, is obtained. (auth)

39745 IDENTITIES INVOLVING THE COEFFICIENTS IN THE ASYMPTOTIC EXPANSION OF THE OUTGOING SCATTERING SOLUTION OF SCHROEDINGER EQUATION. Gelman, Donald (C. W. Post Coll., Greenvale, N. Y.). J. Math. Phys. (N. Y.); 13: No. 6, 871-3(Jun 1972).

Scattering by a short-range potential is described by the wavefunction ψ having the asymptotic form $\psi \rightarrow e^{ik \cdot r} + Fe^{ikr}$, $r \rightarrow \infty$, where F has the series representation $F = f(k, kr)/r + g(k, kr)/r^2 + \cdots$. When only the first term in this series is taken into account, the requirement that the particle current be conserved leads to the optical theorem. By taking into account all of the remaining terms, one obtains a sequence of identities involving the coefficients f,g, · · ·. These identities are formally analogous to the optical theorem, which is seen to correspond to the first identity in the sequence. (auth)

39746 RELATION BETWEEN THE THREE-DIMENSIONAL FREDHOLM DETERMINANT AND THE JOST FUNCTIONS. Newton, Roger G. (Univ., Montpellier, France. Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 13: No. 6, 880-3(Jun 1972).

It is proved that the modified Fredholm determinant F of the three-dimensional Lippmann–Schwinger equation in the theory of scattering by spherically symmetric potentials is related to the Jost functions f_l of angular momentum l by $F = \Pi_{l=0}^{\infty}\{f_l^{2l+1} \exp[(2l + 1)\ \mathrm{Tr}K_l]\}$, where K_l is the kernel of the lth radial Lippmann–Schwinger equation. The relation between the multiplicity of the zeros of F and the degeneracy is discussed, and a relevant theorem for Hilbert–Schmidt operators is proved. (auth)

39747 THREE-NUCLEON SCATTERING CALCULATION USING PERTURBATION THEORY. Sloan, I. H. (Univ. of Maryland, College Park). Nucl. Phys.; A188: No. 1, 193-204 (1972).

A recently proposed perturbation method for three-body collision problems was tested in a calculation of n–d scattering lengths, with the two-nucleon interactions taken to be the S-wave parts of spin-dependent square-well potentials. The corresponding two-body t matrices were expanded as sums of separable terms by using the Weinberg series. The principle of the perturbation method is that a small number of separable terms are treated exactly, and then as many as desired of the remaining terms are treated to the leading order of perturbation theory. In the present application the method is found to be both accurate and practical. It is shown that the method gives good accuracy even if all terms of the Weinberg series beyond the first are treated as perturbations, and on the other hand that there is no difficulty with the perturbation method, in contrast to the standard method of solution, in including the effect of all the separable terms that contribute significantly to the scattering lengths. (3 tables) (auth)

39748 SOLUTIONS OF THE RELATIVISTIC TWO-BODY PROBLEM. II. QUANTUM MECHANICS. Cook, J. L. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 25: No. 2, 141-65(Apr 1972).

The formulation of a quantum mechanical equivalent of the proposed relative time classical theory is discussed. The relativistic wavefunction is derived and a covariant addition theorem is put forward which allows a covariant scattering theory to be established. The free particle eigenfunctions that are given are found not to be plane waves. A covariant partial wave analysis is also given. A means is described of converting wavefunctions that yield probability densities in 4-space to ones that yield the 3-space equivalents. Bound states are considered and covariant analogs of the Coulomb potential, harmonic oscillator potential, inverse cube law of force, square well potential, and two-body fermion interactions are discussed. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

39749 SUPERFLUID HELIUM IN RESTRICTED GEOMETRIES. Padmore, Timothy C. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 28: No. 23, 1512-15(5 Jun 1972).

Superfluid flow in restricted geometries is discussed in the framework of the Landau quasi-particle theory. A recently observed linear temperature dependence of ρ_n for helium flowing in powders is explained in terms of a model geometry which can be fairly described as zero-dimensional. Further experiments are suggested for exploring other features of restricted geometries and testing the zero-dimensional model. (auth)

39750 ION MOTION IN DILUTE ^{3}He–^{4}He SOLUTIONS AT ULTRALOW TEMPERATURES. Kuchnir, M.; Ketterson, J. B.; Roach, P. R. (Argonne National Lab., Ill.). Phys. Rev., A; 6: No. 1, 341-55(Jul 1972).

Measurements of the velocity of charge carriers in several dilute solutions of ^{3}He in ^{4}He in the temperature range 0.017 to 1.0 K are reported. The low-field negative-ion mobility shows a $T^{-½}$ dependence below 0.08 K characteristic of hard-sphere scattering. A maximum is observed in the mobility in the vicinity of 0.4 K. This can be interpreted in terms of a ^{3}He condensation on the bubble surface. The positive-ion mobility is nearly temperature independent below 0.7 K. This has recently been interpreted in terms of a momentum-dependent polarization scattering. The field dependence of the positive-carrier velocity shows a discontinuity in the vortex-ring regime. The discontinuity can be shown to result from a size-dependent drag coefficient and a maximum is observed for very small rings (~16 Å). (auth)

39751 LINEAR VELOCITIES OF PERSISTENT SUPERFLUID-HELIUM CURRENTS AND THE ROLE OF VORTEX LINES. Weaver, James C. (Yale Univ., New Haven). Phys. Rev., A; 6: No. 1, 378-88(Jul 1972).

An investigation of superfluid-helium persistent currents in narrow annular channels is discussed, with an emphasis on the macroscopic linear superfluid velocity v_s. The channels have radial widths $d = R_2 - R_1$ ranging from 8.20×10^{-1} to 8.45×10^{-1} cm, heights from 7.2×10^{-3} to 4.6 cm, and contain no porous filler material. The observed maximum persistent velocities are identified as the superfluid critical velocity $v_{s,c}$ and constitute the first direct measurements of the linear superfluid critical velocity. These experimental values of $v_{s,c}$ are in fair agreement with a simple theory which intimately involves vortex lines. This theory includes a dissipative superfluid critical velocity involving pinned vortex lines which is in over-all agreement with the previous models of Feynman and of Glaberson and Donnelly, but which is especially appropriate for rotational experiments with this geometry. Also, the critical angular velocity of Donnelly and Fetter for the disappearance of vortex lines is associated with the superfluid rather than the bucket in the case of (metastable) persistent currents. Furthermore, it is shown that normal-fluid turbulence was avoided in these measurements and that, therefore, the criticism of Van Alphen et al. does not apply. Nevertheless, the present results do not agree with the empirical Leiden formula. Finally, Andronikashvili's original attempt to observe persistent currents is reexamined. The over-all results of this work strongly support the involvement of vortex lines in superfluid critical velocities for the cases investigated. (auth)

39752 INTERACTION OF CHARGED VORTEX RINGS WITH A SUPERFLUID HELIUM SURFACE. Hosticka, Charlene; Springett, B. E. (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 6: No. 1, 492-8(Jul 1972).

Electrons carried by vortex rings toward a free surface in liquid ^{4}He are found to evaporate from the surface with an energy independent of the ring energy. The energy of the electron is found to depend upon the amount of charge stored near the surface. It is found also that the percentage of the ring current that crosses the surface depends on temperature, ring energy, and conditions at the surface. Finally, a trapped state near the surface is hypothesized, and the results are analyzed in terms of the lifetime of this state. (auth)

39753 BOGOLYUBOV–ZUBAREV DESCRIPTION OF A WEAKLY INTERACTING BOSE GAS. Straley, J. P. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., A; 6: No. 1, 498-505(Jul 1972).

Bogoliubov–Zubarev's exact transformation, specific to a weakly interacting Bose gas having a condensate, yields a Hamiltonian describing a gas of interacting excitations. The non-Hermiticity of the Hamiltonian arises from the nonorthogonality of the physical states; it has some significant consequences. The excitation spectrum is gapless in every approximation; the lowest-order correction is evaluated numerically and shown to be small. It is concluded that the approach presents a prospective method for a quantitative description of the weakly interacting Bose gas. (auth)

39754 COMMENT ON THE THEORY OF TWO-ROTON BOUND STATES. Griffin, Allan (Univ. of Toronto). Phys. Rev., A; 6: No. 1, 512-14(Jul 1972).

It is argued that the recent calculations of Ruvalds and Zawadowski only make sense in the context of a semiphenomenological quantum-hydrodynamic Hamiltonian. In particular, the hybridizing strength is not expected to be simply related to the microscopic condensate fraction n_0. (auth)

39755 THEORETICAL PREDICTION OF AN EFFECT, ANALOGOUS TO THE PELTIER EFFECT IN METALS, IN HE II. Lhuillier, Daniel. Compt. Rend., Ser. B; 274: No. 8, 520-3 (21 Feb 1972). (In French).

Analogies are developed between the equations describing He II with normal blocked fluid, and equations describing a normal metal leading to thermoelectric phenomena. An effect similar to the Peltier effect is predicted. (France)

39756 CHARGED-IMPURITIES-CONCENTRATION WAVES IN He II AS TYPE OF SECOND-SOUND WAVES. Petru, Z. K. (Univ., Wroclaw). Phys. Lett.; 39A: No. 5, 361-2(5 Jun 1972).

The theory of waves of the concentration of charged impurities, generated by temperature waves, in superfluid helium is presented, and a method for its experimental verification is suggested. (auth)

39757 MODIFIED THEORY OF THE KAPITZA RESISTANCE. Haug, H.; Weiss, K. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett.; 40A: No. 1, 19-21(19 Jun 1972).

It is shown that the experimentally found values for the heat resistance of a ^{4}He/solid interface in the millidegree range can be explained by taking into account the phonon absorption in the solid as caused e.g., by scattering on surface dislocations. (auth)

39758 MEASUREMENT OF DIFFUSION IN ^{3}He–^{4}He SOLUTIONS AND DETERMINATION OF THE ^{3}He–ROTON CROSS SECTION. Herzlinger, G. A.; King, J. G. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett.; 40A: No. 1, 65-6(19 Jun 1972).

The diffusion constant of very dilute ^{3}He – ^{4}He solutions was measured directly using a new technique. The results show that the ^{3}He – roton cross section is energy-dependent, increasing with temperature over the temperature range of the experiment. (auth)

39759 SATURATED DISSIPATION IN A He II SUPERFLOW. Francois, M.; Lhuillier, D. (Paris Univ., Orsay, France). Phys. Lett.; 40A: No. 1, 89-90(19 Jun 1972).

Experimental results are presented showing that the superfluid dissipation is limited to a maximum value when the superflow is subjected to the presence of a constriction. (auth)

39760 EVAPORATION FROM SUPERFLUID HELIUM. Cole, Milton W. (Univ. of Toronto). Phys. Rev. Lett.; 28: No. 25, 1622-5(19 Jun 1972).

The angular and spectral distributions of atoms evaporating from superfluid helium were calculated, using a kinetic-theory description of the liquid quasi particles. Phase-space analysis indicates that the evaporation spectrum exhibits information about the single-particle properties of the liquid but, in particular, does not manifest the quasi-particle density of states. The latter conclusion is in agreement with recent experimental results. (auth)

39761 EXTRINSIC DISSIPATION MECHANISM IN FLOW OF SUPERFLUID HELIUM. Hess, George B. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 29: No. 2, 96-9(10 Jul 1972).

Dust particles on the wall of a superfluid flow channel provide sites for generation of quantized vorticity at a low critical velocity. The mechanism is thermal nucleation of vortices in a region of large local velocity near the contact between the particle and the wall. The resulting critical velocity is only weakly temperature-dependent, or possibly temperature-independent, and is consistent in magnitude with experimental critical velocities for a variety of channel sizes and shapes. (auth)

Superconductivity

Refer also to abstracts 38968 and 40143.

39762 (BNL-16891) SUPERCONDUCTING PROPERTIES OF MULTIFILAMENTARY V_3Si WIRES. Suenaga, M.; Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). [1971]. 5p. (CONF-720513-6). Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

A composite superconductor consisting of V_3Si filaments in a Cu–Si matrix was made by the diffusion process which has also been used to produce V_3Ga and Nb_3Sn composites. The critical temperature, T_c, and the critical current density, $J_c(H)$, of this wire were measured for various heat treatments. Degradation of the critical current by bending was also investigated. These results for V_3Si wires are compared with those for Nb_3Sn and V_3Ga wires that were processed similarly and had identical physical geometries. (auth)

39763 (CONF-720513-4) AC STUDIES OF A SUPERCONDUCTING Nb–52 at.% Ti ALLOY. Sekula, S. T.; Kernohan, R. H. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 12p. Dep. NTIS.

From Applied superconductivity meeting; Annapolis, MD. (1 May 1972).

Using a Hartshorn bridge in conjunction with a lock-in amplifier, a signal V_L, proportional to the component of the complex permeability directly related to the losses in a sample, was measured for a cold-worked Nb–52 at.% Ti specimen and a sample heat treated at 1100°C for 1 h. Measurements were carried out at 4.2°K in a dc field H varying from zero to 7 kOe and in a superposed ac (350 Hz) field of amplitude h_0 up to 380 Oe. Power dissipation in the samples was observed to depend somewhat on previous magnetic history. In the cold-worked sample the dependence of energy loss on the amplitude was shown to be cubic for large values of H and h_0, while at smaller values the dependence was seen to be greater than cubic. Measurements of V_L vs H for the cold-worked sample reveal a linear dependence of V_L at the higher values of H. Application of the Bean–London model to these data then shows that the field dependence of the critical current density J_c can be described by a relation of the Kim–Hempstead form $J_c = \alpha/(H + H_0)$. (auth)

39764 (LNF-72/4) POSSIBLE DEVELOPMENT OF SUPERCONDUCTING INSTRUMENTATION WITH WEAK-LINK APPARATUS. Balsamo, E. P.; Paterno, G. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 17 Jan 1972. 9p. (In Italian). Dep. NTIS (U. S. Sales Only).

The signs of the Josephson effect are summarized. Weak-link devices are described and their applications are discussed. Possible use of weak-link apparatus in superconducting instrumentation is then considered. (J.S.R.)

39765 GINSBURG–LANDAU THEORY OF THE VORTEX LATTICE IN TYPE-II SUPERCONDUCTORS FOR ALL VALUES OF κ AND B. Brandt, E. H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi (b); 51: No. 1, 345-58(1 May 1972).

A two-dimensional variational method is established which permits the solution of the Ginsburg–Landau equations for type-II superconductors to any desired accuracy. Free energy, magnetization curves, GL function, microscopic magnetic field and current density are calculated for hexagonal and tetragonal lattice symmetries and for all values of the GL parameter κ and the induction B. The hexagonal lattice is found to be stable throughout. As a further result, simple approximate expressions are found for the free energy (with an error $< 5 \times 10^{-5}$) and for the magnetization as functions of κ and B or the external field H_e. (auth)

39766 GAP ANISOTROPY IN A WEAK COUPLING SUPERCONDUCTOR. Leavens, C. R.; Carbotte, J. P. (McMaster Univ., Hamilton, Ont.). Ann. Phys. (N. Y.); 70: No. 2, 338-77 (Apr 1972).

Formulas are derived for the gap edge and transition temperature of a pure-crystal anisotropic superconductor. The formulas are based on a simplified form of the Eliashberg gap equations applicable in the weak-coupling limit. The kernels of these equations depend on the electron–photon interaction; they are calculated from pseudopotential theory for the electron–ion interaction and a Born–von Karman force constant system for the lattice dynamics. The anisotropy in the gap is calculated at a dense set of points on the irreducible ($^1/_{48}$)th of the Fermi surface. The average gap, critical temperature, and gap anisotropy distribution are all calculated. Comparison is made with specific heat data, and the spin–lattice relaxation is also discussed. (auth)

39767 TYPE-I AND -II SUPERCONDUCTORS. Slivnjak, B. (Univ., Ljubljana, Yugoslavia). Obz. Mat. Fiz.; 19: No. 1, 11-15 (Mar 1972). (In Slovene).

The macroscopic properties of Type-I and Type-II superconductors are briefly reviewed. (auth)

39768 SUPERCONDUCTIVITY OF THE A15 PHASE IN THE Nb–Al–Si SYSTEM. Mueller, A. (Siemens AG, Erlangen, Ger.). Z. Naturforsch.; 26a: No. 6, 1035-9(Jun 1971). (In German).

In the system Nb–Al–Si with more than 60 at.% niobium, the isothermal section at 1840°C was studied. In the range from 75 to 80 at.% silicon, an A15 phase existed. Phase field and lattice constants of the superconducting A15 phase were determined as well as critical current densities and critical temperatures. Single-phase samples of $Nb_{75.3}Al_{21.5}Si_{3.2}$ in the ternary system showed the highest temperature jump at 19.2°K. (tr-auth)

39769 ELECTRON-PAIRING CAPABILITY OF A DIELECTRIC. Leonardi, C. (Univ., Palermo, Italy). Lett. Nuovo Cim.; 3: No. 12, 478-80(18 Mar 1972).

It has been suggested that superconductivity may occur in some organic polymers; the role played by ions in the occurrence of superconductivity in most metals would be played in these systems by the electric polarization of an array of molecules, situated sidewise along the path of the conduction electrons. A simple model consisting of a one-dimensional cylinder containing free electrons and a uniformly distributed, positively charged background is studied. The cylinder is embedded in an infinite isotropic dielectric having a single resonance frequency. The calculations are restricted to two-electron states with zero total momentum. It is found that in such a model the presence of the dielectric may lead to an attraction between the electrons in the cylinder, but that this attraction is not capable of causing the formation of Cooper pairs. (R.W.R.)

39770 CHANGE OF SUPERCONDUCTING TRANSITION TEMPERATURE CAUSED BY ADSORPTION OF NOBLE GASES. Felsch, W.; Glover III, R. E. (Univ. of Maryland, College Park). Solid State Commun.; 10: No. 11, 1033-7(1 Jun 1972).

Surface adsorption of Ne or Xe reduced the superconducting transition temperature of metal films. Shifts, $\Delta T_c/T_c$, for Tl and Sn were larger by a factor of 10 or more than those observed for Pb, Bi and Ga. Small accompanying increases in normal-state conductivity were found for some of the metals and decreases for others. (auth)

39771 METALLURGICAL VARIABLES AND THEIR INFLUENCE ON THE SUPERCONDUCTIVITY OF NIOBIUM–40 PERCENT ZIRCONIUM. Finlayson, T. R.; Milne, I. (Central Electricity Research Labs., Leatherhead, Eng.). Phil. Mag.; 25: No. 6, 1291-1304(Jun 1972).

Superconducting transition temperatures and zero-field critical current densities (computed from low-field magnetization measurements) for Nb–40% Zr are reported as a function of heat treatment. The variation of these properties is correlated with the microstructure which was studied in the same set of specimens using both optical and electron microscopy. The transition temperatures show that the proximity effect of a precipitate phase on a matrix was observed directly. The critical current densities are discussed in comparison with directly measured values for wires of Nb–25% Zr. It is concluded that the achievement of the highest value of critical current correlates with the appearance of a suitable dispersion of the pinning constituent and is independent of the type of pinning constituent. (auth)

39772 SUPERCONDUCTIVITY AND MECHANICAL TWINNING OF TIN WHISKERS. Rothberg, Barbara D. (Univ. of the Witwatersrand, Johannesburg). Phil. Mag.; 25: No. 6, 1473-80(Jun 1972).

The superconducting behavior of certain tin whiskers as a function of strain is interpreted in terms of twinning of the whisker [001] to the [101] axial orientation. The twinned crystal was, in some cases, elastic to 0.5% strain before inhomogeneous plastic slip began. (auth)

39773 EFFECT OF VISCOUS FORCES IN TYPE-II SUPERCONDUCTORS UNDER AC CONDITIONS. Melville, P. H. (Central Electricity Research Labs., Leatherhead, Eng.). Phys. Lett.; 39A: No. 5, 373-4(5 Jun 1972).

Viscous forces on fluxons under ac conditions are shown to be most important in the region in the superconductor where the flux density is zero between regions of fluxons of opposite sign. The results of this effect should be observable in low-pinning superconductors in the frequency range ~100 Hz to ~10 kHz. (auth)

39774 ANISOTROPY AND STRONG-COUPLING EFFECTS ON THE CRITICAL-MAGNETIC-FIELD CURVE OF ELEMENTAL SUPERCONDUCTORS. Gubser, D. U. (Naval Research Lab., Washington, D. C.). Phys. Rev., B; 6: No. 3, 827-31(1 Aug 1972).

An empirical method of separating strong-coupling effects from anisotropy effects in critical-magnetic-field curves of elemental superconductors is presented. Using Clem's critical-field expressions for a weak-coupling anisotropic superconductor, together with an empirical scaling of the superconducting energy gap, a set of relations is derived which allows an independent determination of the mean-squared energy-gap anisotropy parameter $\langle a^2 \rangle$ and a strong-coupling scaling parameter δ. These parameters depend on the experimental determination of two quantities, $2\pi\gamma(T_0/H_0)^2$ and $(dh/dt)_{t=1}$, where T_0 is the zero-field superconducting transition temperature, H_0 is the zero-temperature critical magnetic field, γ is the temperature coefficient of the normal electronic specific heat, and $(dh/dt)_{t=1}$ is the initial slope of the critical-field curve expressed in reduced variables. Values of $\langle a^2 \rangle$ are calculated using published critical-field data and are compared with those values obtained by independent means. (auth)

39775 INTRINSIC FLUCTUATIONS IN A SUPERCONDUCTING RING CLOSED WITH A JOSEPHSON JUNCTION. Kurkijaervi, Juhani (Cornell Univ., Ithaca, N. Y.). Phys. Rev., B; 6: No. 3, 832-5(1 Aug 1972).

The distribution in the external flux at which a superconducting ring closed with a weak link admits a quantum of flux is determined assuming that the weak link can be treated as a Josephson junction. It is found that this transaction occurs at an appreciable fraction of the flux quantum from the theoretical critical external flux. To a first approximation the width of the distribution is proportional to the inductance of the ring and varies as $T^{½} i_c^{-½}$, where T is the temperature and i_c the critical current.

39776 PRESSURE EFFECT ON SUPERCONDUCTING $NbSe_2$ AND NbS_2. Jones, R. E. (Iowa State Univ., Ames); Shanks, H. R.; Finnemore, D. K.; Morosin, B. Phys. Rev., B; 6: No. 3, 835-8 (1 Aug 1972).

The pressure dependence of the superconducting transition temperature T_c was measured for NbS_2 and $NbSe_2$ in order to determine whether tunneling between laminar layers is a dominant factor controlling T_c. Measurements of the lattice constants by x-ray diffraction indicate that both materials are very compressible along the c axis, but T_c measurements do not correlate with the c-axis lattice constant. $NbSe_2$ shows a rapid change in T_c with pressure, whereas NbS_2 shows practically no change at all. T_c measurements correlate with intralaminar changes much better than they correlate with interlaminar spacings. (auth)

39777 TEMPERATURE-DEPENDENT PAIR BREAKING IN LaCe and LaGd. Chaikin, P. M. (Univ. of Pennsylvania, Philadelphia); Mihalisin, T. W. Phys. Rev., B; 6: No. 3, 839-55(1 Aug 1972).

Using multiple-pair-breaking theory, the H_{c2} data were analyzed for pure La and for LaCe and LaGd alloys. For the LaGd samples, a deviation from simple-pair-breaking theory was found, which is caused by the presence of the strong exchange field from the spin-$^7/_2$ impurities. This deviation implies significant Pauli paramagnetic pair breaking for this type of superconductor where the total internal field is large, even though the (externally applied) critical field is small. The LaCe data provide a direct measurement of the spin-flip scattering rate as a function of temperature. The strong temperature dependence observed implied that LaCe is a Kondo system with a characteristic temperature much less than 1 K. The T_c-vs-concentration study shows that impurity–impurity interactions play a large role. (auth)

39778 QUANTUM INTERFERENCE PROPERTIES OF DOUBLE JOSEPHSON JUNCTIONS. Fulton, T. A.; Dunkleberger, L. N.; Dynes, R. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 6: No. 3, 855-75(1 Aug 1972).

The dependence of the critical current I_c on magnetic field B in double Josephson tunnel junctions is discussed in a model which includes the dependence of junction critical currents, magnetic self-screening, and asymmetry. Account is taken both of static (zero-voltage) and dynamic (nonzero-voltage) behavior, the former controlling the over-all shape of $I_c(B)$ and the latter being important in nonadiabatic transitions between multiple states of the junction. The experimental $I_c(B)$ of double Sn/Sn tunnel junctions are interpreted in this model, and display effects of both static and dynamic origin. (auth)

39779 PHASE REVERSAL AND MODULATED FLUX MOTION IN SUPERCONDUCTING THIN FILMS. Kim, Y. W.; de Graaf, A. M.; Chen, J. T.; Friedman, E. J.; Kim, S. H. (Wayne State Univ., Detroit). Phys. Rev., B; 6: No. 3, 887-93(1 Aug 1972).

It is shown that a small magnetic field alternating at audio frequencies causes an amplitude modulation of the electric field associated with the flux motion oscillating at microwave frequencies in superconducting thin films. The phase of the modulation component of this electric field can be changed almost 180° by reversing the sweep of the external magnetic field. These phenomena can be explained by invoking the influence of boundary currents on the motion of the flux lattice. (auth)

39780 ATTRACTIVE INTERACTION BETWEEN VORTICES IN Nb. Finnemore, D. K.; Clem, J. R.; Stromberg, T. F. (Iowa State Univ., Ames). Phys. Rev., B; 6: No. 3, 1056-7(1 Aug 1972).

The equilibrium spacing between vortices a_0 at fields just above H_{c1} has been calculated from previously published magnetization data for Nb. Results show that a_0 is proportional to $(1 - t)^{-½}$, where t is the reduced temperature. Hence, the vortex lattice spacing diverges at the critical temperature in the same manner as the penetration depth and the coherence distance. The magnitude of the lattice spacing is about four coherence distances. (auth)

39781 ASYMMETRY EFFECTS IN SUPERCONDUCTING TUNNELING. Brinkman, W. F.; Tsui, D. C. (Bell Labs., Murray Hill, N. J.). Phys. Rev., B; 6: No. 3, 1063-5(1 Aug 1972).

It is shown that the anomalous enhancements and suppressions of the Pb superconducting density of states observed in Si/Pb tunnel junctions are results of the asymmetric normal-state conductance. (auth)

39782 MAGNETIZATION OF HYSTERETIC LOW-κ TYPE-II SUPERCONDUCTORS. Pfeiffer, Kurt; Papp, Reiner; Weber, Harald W. (Oesterreichische Hochschule, Vienna). Acta Phys. Austr.; 34: No. 3, 227-34 (1971).

Calculations on the magnetization of low-κ type-II superconductors differing in their degree of hysteresis are presented and compared with experimental results on various niobium and vanadium samples. The basis of the theory is the equation-of-force balance between the pinning force and the Lorentz force. The resulting differential equation for a cylindrical superconductor with its axis parallel to the external field is solved with suitable boundary conditions to account for the Meissner effect and the influence of the reversible magnetization. The results demonstrate the applicability of the concept of the critical state to low-κ superconductors. (auth)

39783 NEW MACROSCOPIC QUANTUM EFFECT IN A TYPE-II SUPERCONDUCTOR. Sugahara, Masanori (Yokohama National Univ., Japan). Phys. Rev. Lett.; 29: No. 2, 99-101(10 Jul 1972).

A series of structures is observed in the field dependence of the current threshold of a type-II superconductor in a longitudinal magnetic field. In the mixed state the structures appear in the field $H = H_{c2}/N$ (H_{c2} is the upper critical field; N is an integer), while for the case $H > H_{c2}$, they are observed when $H = N^{½}H_{c2}$. These phenomena are discussed on the basis of the Ginzburg–Landau equation. The experimental data in the mixed state are interpreted as evidence for the existence of some new quantum states other than the Abrikosov state. (auth)

Equipment and Devices

Refer also to abstracts 39041–39043, 39047, 39049, and 39050.

PHYSICS (NUCLEAR)

39784 (ANU-P-546) NUCLEAR PHYSICS IN EUROPE, 1970/71. Nurzynski, J. (Australian National Univ., Canberra. Dept. of Nuclear Physics). [1971]. 66p. Dep. NTIS (U. S. Sales Only).

A description is given of the facilities present at nuclear physics research institutions in Denmark, Poland, Sweden, Switzerland, United Kingdom and the German Federal Republic. On the basis of this study recommendations are made with respect to research programs and facilities at ANU. (M.R.M.)

39785 (LUNP-7201) ANNUAL REPORT, 1971. (Lund Univ. (Sweden). Lund Inst. of Tech. (Sweden)). Jan 1972. 111p. Dep. NTIS (U. S. Sales Only).

This annual report reviews the research carried out at the Departments of Cosmic High Energy Physics, Elementary Particle Physics, and Nuclear Physics of the University of Lund and the Lund Institute of Technology. The connections of these departments are strong with integrated research and education. They are housed in a common building, have common electronic and mechanical workshops and a common computer station. The equipment is dominated by three accelerators: a 1.2 GeV electron synchrotron, a 3 MeV Van de Graaff generator and a 0.4 MeV neutron generator. The three departments are integrated parts of a center of physics to which departments of atomic physics, electronics, mathematical physics, solid state physics and theoretical physics belong. The research of these latter departments is not reviewed here. (auth) (Sweden)

Neutron Interactions with Matter

Refer also to abstracts 39837, 40055, and 40066.

39786 (INR-1386) SINGLE ROTOR, SUBTHERMAL NEUTRON MONOCHROMATOR. Graffstein, Andrzej; Rzeszot, Tadeusz, Warda, Eugeniusz (Institute of Nuclear Research, Warsaw (Poland)). 1972. 18p. (In Polish). Dep. NTIS (U. S. Sales Only).

To extend the pulsed neutron measurements of polycrystalline moderators to the region of subthermal energies, a mechanical neutron monochromator has been constructed. Assumptions, the method of the slit shape calculation, and some physical characteristics of the monochromator are presented. (auth)

39787 (JINR-E3-6294) SOME PECULIARITIES OF SCATTERING OF SLOW NEUTRONS BY TUNGSTEN. Aleksandrov, Yu. A.; Ignatovich, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 8p. Dep. NTIS (U. S. Sales Only).

Experiments on the diffraction of neutrons by a single ^{186}W crystal and the small-angle scattering of neutrons by powder of ^{186}W are analyzed. The occurrence of a small additional coherent scattering of neutrons by tungsten could explain these experiments. (auth)

39788 (KFK-1489) INVESTIGATION OF MOLECULAR ROTATION IN SOLID METHANE BY INELASTIC NEUTRON SCATTERING. Kapulla, Hans (Kernforschungszentrum, Karlsruhe (West Germany)). Jan 1972. 73p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

With a rotating crystal spectrometer at the cold neutron source of the reactor FR2 the double differential scattering cross section of CH_4 was measured in the range of temperatures between 4.4°K and 21°K. The incident energy of the neutrons was 5 MeV ($\lambda \simeq 4$ Å). The experiments described in this work were the first ones to show unequivocally that there are rotations in methane at 4.4°K. Discrete energy changes in the spectra of scattered cold neutrons can be attributed to rotational motions. These energy changes are slightly smaller than those expected for free rotations. From the cross section ratio for the rotational transitions 0−1 and 1−0 it was concluded that only a small percentage of all the molecules in pure, O_2-free CH_4 of 4.4°K are converted into the energetically most favorable rotational state of $J = 0$ with the nuclear spin $I = 2$. Doping the methane with oxygen increases the rate of conversion but does not lead to thermal equilibrium. This was also deduced from the magnitude of the cross section ratio. The scattering cross section did not show any changes due to the lower λ-point. The cross section for the hindered 0−1 transition decreases smoothly with temperature. A comparison between the absolute value of the scattering cross section for the 0−1 transition at 4.4°K and the one for elastic scattering shows that very probably only one quarter of all CH_4 molecules participate in the hindered rotation. Free rotations as discrete transitions were not observed over the whole temperature range investigated. The increase in inelastic or quasielastic scattering with increasing temperature, in which mainly processes of small energy exchanges participate, is explained by increasing rotational diffusion. Above the conversion point at 20.5°K a sudden increase of the contribution of rotational diffusion has been observed. (auth)

39789 DIFFERENTIAL AND INTEGRAL MEASUREMENTS OF AN INTERMEDIATE NEUTRON SPECTRUM. Nanjyo, Tsutomu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 5, 290-300(May 1972).

The neutron spectrum in an intermediate neutron system composed of C, B and Al was measured by two methods: one based on TOF (time-of-flight), which aims at establishing the system as a standard or reference neutron spectral field, and the other the 1/v-filter difference method which is a new departure. In the latter method, a set of count rates obtained with a small BF_3 counter sheathed in ^{10}B-filters of different thicknesses is unfolded into the neutron spectrum. Two successful unfolding methods, i.e., least-squares series expansion and count rate iteration, are demonstrated. By the TOF method, the neutron spectrum is determined in detail with satisfactory accuracy, while by the other method, a rough outline of the neutron spectrum under 1 keV is obtained. Some discrepancy is found between the TOF and the theoretical results. It is concluded that the 1/v-filter difference method is useful as an easy method of estimating an intermediate neutron spectrum. (auth)

39790 NEUTRON FLUX DISCONTINUITIES DUE TO INELASTIC SCATTERING. Beynon, T. D. (Univ. of Birmingham, Eng.). J. Nucl Energy; 26: No. 4, 177-88(Apr 1972).

It is shown that if inelastic scattering participates in the slowing down of neutrons each excited state in the target nucleus will contribute two discontinuities to the neutron collision density function produced by a monoenergetic source of neutrons. These are in addition to the single Placzek discontinuity associated with elastic scattering. The increased oscillatory behavior in the neutron field due to discontinuous energy derivatives is examined. Some numerical samples for a typical fast reactor dilutant like ^{56}Fe show that these additional discontinuities can be of more practical importance than the Placzek discontinuities. (auth)

39791 ASYMMETRIC TOTAL REFLECTION OF POLARIZED NEUTRONS AND THE NEUTRON AS A SURFACE PROBE. Handel, Peter H. (Univ of Missouri, St. Louis). Z. Phys.; 252: No. 1, 7-11(1972).

Total reflection of neutrons which are polarized perpendicular to the plane of incidence is invariant to beam reversal in the usual formalism of the index of refraction for neutrons. A modified formalism which includes the spin-orbit interaction of the neutrons in the electric field present at the surface of the reflecting medium is developed in this paper. The asymmetry predicted is proportional to the surface dipole potential of the mirror and provides a method of direct measurement of the surface dipole. (auth)

39792 QUANTUM THEORY OF THE SHADOW EFFECT DURING SCATTERING OF β-PARTICLES AND NEUTRONS. Svetogorov, D. E. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 512-19(Sep-Oct 1971). (In Russian)

The scattering of spherically divergent beams of fast neutrons by an external potential produced by a crystal lattice was examined using the Born approximation. An expression was obtained for the density of particles emerging, and was utilized in turn for interpreting the "shadow" effect in β particle scattering. The possibility of observing an analogous effect in the scattering of neutrons by nuclei in a lattice is discussed. (tr-auth)

39793 SPACE DEPENDENT NEUTRON SPECTRA IN THE PRISMS OF CRYSTALLINE MEDIA. Takahashi, Akito (Osaka Univ.); Fujita, Yoshiaki. J. Nucl. Sci. Technol. (Tokyo); 9: No. 5, 281-9(May 1972).

In an effort to elucidate the space dependent spectral behavior of thermal and cold neutrons in crystalline media, calculations in lead and graphite prisms were carried out using the successive collision method based on the integral transport theory, and also using the successive inelastic scattering method based on the distributed source diffusion theory. The results were compared with experiments to measure the space dependent energy spectra in a lead prism generated by the "thermal" and the "cold" sources. The space dependent spectra in small crystalline media are modified below the Bragg cut-off energy by the deep penetration of neutrons and acquire the characteristic sharp peak. Above the Bragg cut-off energy, near Maxwellian spectra are generated in graphite prisms, while in small lead prisms the spectra are strongly affected by the neutron penetration below about 0.01 eV. Calculations by the distributed source diffusion theory showed good approximate spectra. (auth)

39794 POTENTIAL OF A LASER-INDUCED FUSION DEVICE AS A THERMAL-NEUTRON SOURCE. Brugger, R. M. (Aerojet Nuclear Co., Idaho Falls, Idaho). Nucl. Technol.; 15: No. 3, 14-24(Jul 1972).

Anticipating that a laser-induced fusion reaction will eventually be achieved, the potential of such a system as a source of thermal neutrons is considered. This source should provide bursts of thermal neutrons which would be at least three orders of magnitude more intense for time-of-flight experiments than the best existing neutron source. The major limiting factor appears to be the shock produced when each pellet reacts; this shock must be contained within the target room and should not destroy the moderators. Estimates indicate that this shock can be controlled. Consideration has also been given to moderator design, shielding, beam tube windows and backgrounds. (auth)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 39563 and 39823.

39795 (IFA-FT-93) SHORT-RANGE CORRELATION CALCULATIONS IN ^{4}He. Iosifescu, M.; Scutaru, H. (Institutul de Fizica Atomica, Bucharest (Romania)). Mar 1972. 13p. Dep. NTIS (U. S. Sales Only).

The nuclear binding energy and charge form factor of ^{4}He were calculated by a variational method using short-range correlated trial functions. Four different realistic soft-core spin-dependent potentials were used. Some qualitative conclusions regarding the best shape for the central N–N potential were drawn. A quasi-periodic set of diffraction minima in the form factor was found. (J.W.R.)

39796 (ORO-4317-4) PADE APPROXIMANTS AND NUCLEON-DEUTERON SCATTERING. Technical Report No. 72-093. Brady, T. J.; Sloan, I. H. (Maryland Univ., College Park. Dept. of Physics and Astronomy). [1971]. 8p. Dep. NTIS.

The Padé approximant method of Kloet and Tjon is tested in a calculation of n–d scattering with separable potentials, where the exact result is already known. The method is found to work extremely well. (auth)

39797 NEW LEVELS OF ^{4}He AND DIFFERENCE IN ANGULAR DISTRIBUTIONS IN D(d,n)^{3}He AND D(d,p)^{3}H REACTIONS. Sergeev, V. A. Kratk. Soobshch. Fiz.; No. 11, 37-44(Nov 1971). (In Russian).

New ^{4}He levels with T = 0 were introduced on the basis of theoretical considerations, where the levels possessed small nucleon and single-particle deuteron widths, which make a basic contribution to the anisotropy of d + d reactions ($E_d < 2$ MeV). Anisotropy of the differential cross sections was calculated for the reactions D(d,n)^{3}He and D(d,p)^{3}H. (K.S.W.)

39798 POLARIZATION AND POLARIZATION TRANSFER IN THE REACTION T(p,n)^{3}He. Haight, R. C. (Los Alamos Scientific Lab., N. Mex.); Simmons, J. E.; Donoghue, T. R. Phys. Rev., C; 5: No. 6, 1826-34(Jun 1972).

The polarization-transfer coefficients $K_y^y(\theta)$, $K_x^{x'}(\theta)$, and $K_z^{x'}(\theta)$ in the reaction T(p,n)^{3}He were measured for seven laboratory angles between 15 and 120° at $E_p = 13.55$ MeV. At $E_p = 8.94$ MeV, $K_x^{x'}(30°)$ and $K_z^{x'}(30°)$ were determined. In addition, the polarization function, P(θ), was measured at 13.55 MeV. The previously reported polarization-transfer data at 0° as a function of energy are given here in more detail. Comparisons are made with R-matrix calculations based on the analysis of Werntz and Meyerhof. (6 figures, 2 tables) (auth)

39799 MEASUREMENT OF THE COHERENT-SCATTERING AMPLITUDE OF TRITIUM. Donaldson, R. E.; Bartolini, W.; Otsuki, H. (Univ. of California, Livermore). Phys. Rev., C; 5: No. 6, 1952-5(Jun 1972).

The coherent scattering amplitude of tritium was measured by a multiple-refraction method. A finely collimated beam of neutrons was passed through a powder alternately in vacuum and in a nonabsorbing fluid. The relative broadening of the neutron beam was determined by the coherent scattering amplitudes of the powder and the fluid. In this experiment, the powders were silicon and diamond, and the fluids were deuterium and tritium with densities up to 440 amagat. The coherent scattering amplitude of tritium was determined relative to deuterium; a value of $a_D = +6.21 \pm 0.04$ F from mirror measurements was used. The value obtained for tritium was $a_T = +4.7 \pm 0.3$ F. It should be noted that the value of $a_D = +6.21$ F is at variance with other measurements of a_D. If the accepted value of $a_D = 6.7 \pm 0.1$ F is used, the coherent scattering amplitude of tritium is $a_T = 5.0 \pm 0.3$ F. (6 figures) (auth)

39800 MAJORANA COMPONENT IN THE IMAGINARY POTENTIAL FOR p + α SCATTERING. Thompson, D. R.; Tang, Y. C.; Brown, Ronald E. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 5: No. 6, 1939-47(Jun 1972).

A phenomenological, imaginary potential is incorporated into resonating-group calculations for the p + α system. The introduction of this potential allows, at energies above the reaction threshold of 18.35 MeV (c.m.), a more detailed comparison with experiment than was possible with previous resonating-group calculations. The calculations are compared with elastic scattering differential-cross-section data, polarization data, and spin-rotation-parameter data which exist between 23 and 75 MeV (c.m.). From this comparison it is concluded that a Majorana component whose strength varies with energy is very likely present in the imaginary potential. (7 figures, 3 tables) (auth)

39801 TWO-BODY PHOTODISINTEGRATION OF ^{3}He BETWEEN 40 AND 150 MeV. O'Fallon, Nancy M.; Koester, Louis J. Jr.; Smith, James H. (Univ. of Illinois, Urbana). Phys. Rev., C; 5: No. 6, 1926-38(Jun 1972).

In an experiment with semiconductor and scintillation counter telescopes the photodisintegration cross section of ^{3}He was measured at photon energies from 40 to 150 MeV and proton laboratory angles of 30, 60, 90, 120, and 135°. (15 figures, 3 tables) (auth)

39802 MODEL FOR SHORT RANGE CORRELATION IN THE THREE-BODY SYSTEM. Hadjimichael, E.; Yang, S. N.; Brown, G. E. (State Univ. of New York, Stony Brook). Phys. Lett.; 39: No. 5, 594-8(29 May 1972).

A method by means of which the two-body short-range correlations in the nucleon–nucleon interaction are taken accurately into account in three-body bound-state calculations is described. The method is independent of the nucleon–nucleon interaction. The method is used to calculate meson-exchange corrections to the magnetic moments of ^{3}H and ^{3}He and the Coulomb energy of ^{3}He. (auth)

39803 DIRECT SOLUTION OF THE HILL-WHEELER EQUATION FOR ALPHA-ALPHA SCATTERING. de Takacsy, N. B. (McGill Univ., Montreal). Phys. Rev., C; 5: No. 6, 1883-8(Jun 1972).

In the cluster model of Brink, Margenau, and Bloch, the motion of two clusters is described by an integral equation for the generator-coordinate amplitude. It is shown that a direct solution of this Hill–Wheeler equation provides a practical framework for the study of cluster–cluster scattering; however, the Coulomb potential is not yet included in the formalism. The case of $\alpha + \alpha$ scattering (with the Coulomb potential neglected) is studied in some detail, and dineutron–dineutron scattering is also mentioned. (3 figures, 2 tables) (auth)

39804 TRIPLE SCATTERING MEASUREMENTS FOR THE PROTON-DEUTERON SYSTEM. Stewart, N. M. (King's Coll., London); Gibson, W. R. Nucl. Phys.; A188: No. 1, 205-11(1972).

Measurements of the Wolfenstein parameter A for the elastic scattering of 48.3-MeV polarized protons by liquid deuterium were made in the angular range 40° to 70° lab. These results, together with the previously reported values for D and R, are compared with existing impulse-approximation calculations and experimental results at higher energies. (auth)

39805 REVIEW OF THE LOW ENERGY SCATTERING CROSS SECTIONS OF DEUTERIUM. Leonard, B. R. Jr. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 15: No. 3, 49-55(Jul 1972).

The parameters of the interaction of slow neutrons with deuterium are important in the development of theories of nucleon-nucleon interactions. They also determine the slowing down of neutrons in D_2O systems as characterized by the calculational benchmark of the neutron age. Differential measurements of claimed high accuracy have been reported in the past several years which cast doubt on the knowledge of these parameters. A consistent set of parameters which will also reproduce the neutron age can be derived from precision measurements only by rejecting two measurements of claimed high accuracy. There remains a need for further differential measurements of adequate precision to verify the choice of neutron-deuterium parameters. (auth)

39806 NEUTRON-DEUTERON SCATTERING AT 152 MeV. Palmieri, J. N. (Oberlin Coll., Ohio. Harvard Univ., Cambridge, Mass.). Nucl. Phys.; A188: No. 1, 72-6(1972).

The elastic and inelastic neutron–deuteron differential cross sections were measured for a neutron energy of 152 MeV. Deuterons and protons were detected in the angular range of 5° to 40° relative to the incident neutron beam. The results for elastically scattered particles are reasonably consistent with earlier proton–deuteron measurements. The theoretical analysis of the inelastic scattering results appears in a separate paper. (1 figure) (auth)

39807 INELASTIC NEUTRON-DEUTERON SCATTERING AT 152 MeV. Cromer, A. H. (Northeastern Univ., Boston); Palmieri, J. N. Nucl. Phys.; A188: No. 1, 77-82(1972).

The spectra of protons from the reaction $^2H(n,p)2n$ were measured for 152-MeV incident neutrons. These spectra are compared to theoretical predictions into which the energy spread of the neutron beam and the energy resolution of the apparatus were folded. The folding procedure uses the spectra of protons measured in an h–p charge-exchange scattering experiment performed with the same equipment. The predictions are in excellent agreement with the observed results. (2 figures) (auth)

39808 INVESTIGATION OF EXCITED STATES OF ^{4}He THROUGH DEUTERON-INDUCED THREE-PARTICLE REACTIONS ON ^{6}Li. Haase, E. L.; Hagelberg, R.; Wang, W. N. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Nucl. Phys.; A188: No. 1, 89-96(1972).

Excited states of ^{4}He are investigated through final-state interactions in the three-particle reactions $^6Li(d,\alpha t)^1H$, $^6Li(d,\alpha ^3He)n$, and $^6Li(d,\alpha d)^2H$ with 52-MeV deuterons. In measuring the differential cross sections, the detector of the first outgoing particle was kept at a fixed position; and the second detector, scanned over a range of coplanar angles favoring ^{4}He final-state interactions. The data are interpreted in terms of four isospin T = 0 excited states of ^{4}He at 21.9, 25.5, 28.5, and 31.8 MeV with widths of 1.8, 2.9, 5.3, and 5.6 MeV, respectively. Only the 21.9 and the 25.5-MeV levels are particularly evident. Angular correlation data indicate $J^\pi = 0^+$ or 1^+ for the level at 25.5 MeV. No evidence is found for a narrow state at 23.9 MeV. (4 figures) (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 39136, 39563, 39808, 39834, 39844, 39886, 39904, 39918, and 40180.

39809 (IAE–2033) STUDY OF THE Li + Li REACTIONS AND THE POSSIBLE EXISTENCE OF THREE-CLUSTER STATES. Glukhov, Yu. A.; Novatskii, B. G.; Ogloblin, A. A.; Sakuta, S. B.; Stepanov, D. N.; Chuev, V. I. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

(^{6}Li,α) and (^{7}Li,α) reactions were investigated on the target nuclei ^{6}Li and ^{7}Li at 26 and 30 MeV, respectively. An intense excitation was observed at levels near the three-particle thresholds: $^8Be \rightarrow \alpha + d + d$, $^9Be \rightarrow \alpha + t + d$, and $^{10}Be \rightarrow \alpha + t + t$. It is suggested that a three-cluster structure be assigned to some of these states. (tr-auth) (3 figures)

39810 (JINR–P1-6362) CARBON ANALYZING POWER IN SCATTERING OF 460- AND 550-MeV PROTONS. Glonti, L. N.; Kazarinov, Yu. M.; Potashnikova, I. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The carbon analyzing power for polarized protons has been measured as a function of the proton scattering angle. The measurements were made by observing the azimuthal scattering asymmetry produced by the proton polarized beam in a carbon target. No attempt was made to separate the contribution of inelastic channels. The measurements were carried out by means of two independent scintillation counter telescopes having a low detection threshold for scattered protons. To obtain the beam of the necessary energy the 635-MeV, 42.5% polarized proton beam was slowed down by CH_2 blocks. The results for the differential cross section of p–C scattering at 460 MeV and carbon analyzing power angular dependence at 460 MeV and 550 MeV are presented. From the comparison of p–C elastic scattering differential cross section with the results it follows that inelastic channels make a great contribution at angles larger than 10°. The efficiency of the telescopes to inelastic channel protons was close to the spark chamber one. So, the results for analyzing power measured in the experiment may be used for analyzing the polarization data obtained in the spark chamber experiments with the low energy threshold. (auth)

39811 (ORNL–4743) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1971. Obenshain, Felix E. (ed.) (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 203p. Dep. NTIS.

ATOMS—properties of toroidal-nucleus, Thomas–Fermi calculation of, (T), p. 20-22
BISMUTH-209—proton fission at 36.1 MeV, mass distribution and neutron emission function for, (E), p. 90-92
CADMIUM-113—energy level at 315.8 keV from proton inelastic scattering, lifetime of, (E), p. 73-74
CALCIUM-40—neutron total cross section at 10 to 100 keV, (E), p. 54-56
CALCIUM-42—neutron total cross section at 10 to 100 keV, (E), p. 54-56
CALCIUM-43—neutron total cross section at 10 to 100 keV, (E), p. 54-56
CALCIUM-44—neutron total cross section at 10 to 100 keV, (E), p. 54-56
DEUTERONS—interactions π^+ + d at 7.9 GeV/c, multipion mass spectra from, (E), p. 24-26
FERMIUM-252—fission of, two-center model calculation of asymmetric spontaneous, (T), p. 94-98
FERMIUM-264—fission of, two-center model calculation of asymmetric spontaneous, (T), p. 94-98
FLUORINE IONS—electron autoionization spectra from beams of, p. 109-111
FLUORINE-18—energy levels of, comparison of shell-model calculations with effective interactions for, (T), p. 10-12
HELIUM-3—alpha scattering at 63.7, 71.7, and 81.4 MeV, analysis of resonance in, (E), p. 31-34
IRON—neutron total cross section at 20 to 500 keV, (E), p. 52-54
LEAD-208—proton inelastic scattering at 55 MeV, proton spectra from, (E), p. 82-83
MESONS (π^+)—interactions π^+ + d at 7.9 GeV/c, multipion mass spectra from, (E), p. 24-26
MOLYBDENUM-92—energy levels from molybdenum-94 (p,t) reactions, spin-parity assignments for, (E), p. 61-62
—neutron capture at 0.3 to 100 keV, γ spectra from, (E), p. 63-68
MOLYBDENUM-93—energy levels from molybdenum-92 neutron capture, (E), p. 63-68
MOLYBDENUM-94—energy levels from molybdenum-96 (p,t) reactions, spin-parity assignments for, (E), p. 61-62
NEON-20—energy levels of, comparison of shell-model calculations with effective interactions for, (T), p. 10-12
NICKEL-58—oxygen-16 reactions (O-16, 2pγ) at 38 to 46 MeV, energy dependence of yields for rotational states in, (E), p. 57-60
NICKEL-60—helium-3 elastic scattering at 29.6 to 71.1 MeV, optical-model analysis of, (E/T), p. 48-52
NUCLEI—toroidal shapes for, (T), p. 20-22
OXYGEN IONS—electron autoionization spectra from beams of, p. 109-111
OXYGEN-16—neutron total cross section at 0.6 to 4 MeV, (E), p. 39-40
—neutron reactions up to 5.8 MeV, R-matrix analysis of, (E/T), p. 37-38
OXYGEN-20—energy levels of, comparison of shell-model calculations with effective interactions for, (T), p. 10-12
RUBIDIUM URANYL NITRATES—uranium-234 Moessbauer spectra in, p. 100-102
SELENIUM-72—energy-level scheme from bromine-72 decay, (E), p. 43
—energy-level scheme from heavy ion reactions, (E), p. 60
SELENIUM-74—energy-level scheme from heavy ion reactions, (E), p. 60
SILVER-109—helium-3 reactions (He-3,d) at 26 MeV, deutero spectra from, (E), p. 72-73
THULIUM-170—energy levels from thulium-169 neutron capture, spin assignments for, (E), p. 79
URANIUM-234—Moessbauer spectra in rubidium uranyl nitrate, p. 100-102
URANIUM-235—neutron fission at 0.25 eV to 50 keV, energy spectra of fragments from, (E), p. 88-89
URANIUM-236—fission of, two-center model calculation of asymmetric spontaneous, (T), p. 94-98

ZIRCONIUM-91—proton reactions (p,t) at 31 MeV, DWBA analysis of angular distributions for, (E), p. 69-70 (J.W.R.)

39812 (ORO-4043-5) EXPERIMENTS ON THE NUCLEAR INTERACTIONS OF PIONS. Progress Report, September 1, 1971–August 31, 1972. McCarthy, J. S.; Minehart, R. C.; Sobottka, S. E.; Ziock, K. O. H. (Virginia Univ., Charlottesville). 1972. Contract AT(40-1)-4043. 91p. Dep. NTIS.

Data analysis for our $\pi^{\pm}$ + ^{16}O elastic scattering experiment has been completed and a Kisslinger optical model with reasonable nuclear parameters agrees well with the data. A new upper limit of 1.15 MeV on the mass of the muon neutrino has been measured. Preliminary analysis of data from our (π^+,2p) experiment shows less excitation to T = 1 states than predicted for ^{16}O and ^{16}N targets, and deviations from the pole model for a ^{6}Li target. A new type of proportional chamber capable of spatial resolutions of 0.22 mm fwhm with minimum ionizing particles has been developed for the EPICS spectrometer. The optical and magnetic design for the EPICS spectrometer has been completed. Our studies indicate that detection of electrons from πe_2 decay will be useful for monitoring EPICS beams. Operating conditions for optimum stopping pion beams have been calculated for the LAMPF low energy pion channel. Beam monitoring and diagnostics for the P^3 channel have been studied and techniques using pion–proton scattering and differential Cherenkov counters both appear to be useful. We are presently Chairmen of the LAMPF EPICS and Low Energy Pion Channel Working Groups and members of the Technical Advisory Panel. (auth)

39813 STUDY OF THE EXCITED STATES OF ^{15}O BETWEEN 10 AND 10.5 MeV. Chambon, B.; Diallo, O.; Lambert, M.; (and others) (Univ. Claude Bernard de Lyon, Villeurbanne, France). Nuovo Cim.; 9A: No. 3, 283-99(1 Jun 1972). (In French).

Proton elastic scattering on ^{14}N is studied in the region E_p = 3 to 3.55 MeV. Four resonances are observed at E_p = 3209, 3215, 3410 and 3440 keV with widths of Γ = (3 ± 1), (11 ± 2), (25 ± 5), (140 ± 40) keV and J^{π} values of $(5/2)^-$, $5/2^+$, $(3/2)^-$ and $(3/2)^+$ corresponding to excited states in ^{15}O at E_x = 10,286, 10,292, 10,474 and 10,502 keV, respectively. (auth)

39814 NUCLEAR MOLECULAR STRUCTURE IN ^{12}C–^{12}C SCATTERING Fink, H -J.; Scheid, W.; Greiner, W. (Univ., Frankfurt am Main). Nucl. Phys.; A188: No. 2, 259-88(1972).

A model for the scattering of identical nuclei is proposed which includes inelastic excitations of the individual nuclei. The potentials between the nuclei are calculated in an extended liquid-drop model. The absorptive part of the optical potential is related to the level density of the compound states in the framework of the statistical model. In a coupled-channel calculation, the elastic and inelastic ^{12}C – ^{12}C scattering cross sections are obtained, which show qualitative agreement with the experimental data. (auth)

39815 NUCLEAR CHARGE RADII OF ^{12}C AND ^{9}Be. Jansen, J. A.; Peerdeman, R. Th.; De Vries, C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys.; A188: No. 2, 337-52(1972).

Absolute cross sections for the elastic scattering of electrons by ^{12}C and ^{9}Be have been measured with an accuracy of about 1% for momentum transfers ranging from 0.15–0.7 fm^{-1}. The nuclear radii derived from these data by means of phase-shift calculations are: ^{12}C: 2.445 ± 0.015 fm (Fermi model) and 2.453 ± 0.008 fm (shell model); ^{9}Be: 2.519 ± 0.012 fm (shell model, Q = 3.2 ± 1.2 fm^2). (auth)

39816 QUASIFREE SCATTERING OF ELECTRONS FROM ^{12}C. Radhakant, S. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A188: No. 2, 353-68(1972).

The scattering of high-energy electrons from ^{12}C, accompanied by the knock-out of one proton, is studied using the Born approximation. The effects of using distorted waves for the outgoing proton and realistic wave functions for the bound states of ^{12}C on the coincidence cross section are studied. The results are compared with those of simpler models and also with experiment. (auth)

39817 HEAVY-ION EMISSION FROM LIGHT NUCLEI. Rudy, C.; Vandenbosch, R.; Russo, P.; Braithwaite, W. J. (Univ. of Washington, Seattle). Nucl. Phys.; A188: No. 2, 430-48(1972).

Reactions involving the emission of heavy ions leading to low-lying states of the residual nucleus have been studied using 42 MeV α-particles incident on light target nuclei. The heavy ions resulting from these reactions were identified by mass number using the time-of-flight technique. With this method, products with a mass number as high as A = 14 could generally be separated from neighboring isobars. Reactions leading to different particle masses from a particular target were studied simultaneously. Angular distributions and total cross sections were obtained for the reactions ^{12}C(^{4}He,^{6}Li)^{10}B, ^{12}C(^{4}He,^{7}Be)^{9}Be, ^{16}O(^{4}He,^{6}Li)^{14}N, ^{16}O(^{4}He,^{7}Li)^{13}N, ^{16}O(^{4}He,^{7}Be)^{13}C and ^{16}O(^{4}He,^{9}Be)^{11}C. A comparison of the experimental angular distributions and cross sections with statistical model calculations was carried out. It is shown that as the mass of the emitted heavy ion increases for a particular reaction, the fractional contribution of compound-nuclear processes increases. Considerable compound-nuclear contributions to all the reactions studied are indicated. Comparison of the calculated and experimental results for the ^{16}O(^{4}He,^{7}Be) and ^{16}O(^{4}He,^{7}Li) reactions with those for the reaction ^{16}O(^{4}He,^{8}Be)^{12}C indicate that there is no enhancement of the latter reaction due to α-clustering. Evidence is given for the conservation of isotopic spin in complex reactions proceeding through a short-lived compound nucleus. The possible astrophysical significance of low-energy α-particle-induced reactions in the nucleosynthesis of Li, Be and B is discussed. (auth)

39818 TWO STEP PROCESS IN THE ^{16}O(p,2p)^{15}N REACTION. Geramb, H. V.; Strobel, G. L. (Kernforschungsanlage, Juelich, Ger.). Phys. Lett.; 39B: No. 5, 611-14(29 May 1972).

A two step core polarization term is included in calculating the (p,2p) reaction amplitude. When this mechanism is comparable to the usual valence contribution, one can explain the experimental data. (auth)

39819 DISPERSION CORRECTIONS TO ELASTIC ELECTRON SCATTERING BY ^{16}O AND ^{12}C. Friar, J. L. (Massachusetts Inst. of Tech., Cambridge); Rosen, M. Phys. Lett.; 39B: No. 5, 615-19(29 May 1972).

Longitudinal dispersion corrections to elastic electron scattering from ^{16}O and ^{12}C are calculated using oscillator wave functions and closure approximation. Near the first diffraction minimum, the contributions from the Pauli, COM and self-correlations almost cancel. The correction increases away from the minimum. (auth)

39820 OBSERVATION OF A MISSING STATE IN ^{17}F. Thornton S. T. (Univ. of Virginia, Charlottesville). Phys. Lett.; 39B: No. 5, 623-4(29 May 1972).

A state at 5.18 ± 0.02 MeV in ^{17}F has been observed with the ^{15}N(τ,n)^{17}F reaction, thereby completely matching the (mirror) states of ^{17}O and ^{17}F through the first twelve levels (up to 6.0 MeV excitation energy). (auth)

39821 STUDY OF REACTION MECHANISMS FOR THE ^{7}Li (p,2d)^{4}He REACTION AT 45 MeV. Furic, M.; Cole, R. K.; Forster, H. H.; (and others) (Univ. of Southern California, Los Angeles). Phys. Lett.; 39B: No. 5, 629-31(29 May 1972).

The first kinematically complete experiment involving a (p,2d) reaction is reported. It is found that at 45 MeV bombarding energy a significant part of the ^{7}Li(p,2d)^{4}He reaction cross section arises from contributions from sequential decay processes through excited states of ^{6}Li. A new three-body break-up mechanism involving the quasi-free interaction of the proton with the bound triton is discussed. (auth)

39822 ^{18}O + ^{16}O ELASTIC SCATTERING IN THE ENERGY RANGE $E_{c.m.}$ = 13 TO 33 MeV. Siemssen, R. H.; Fortune, H. T.; Richter, A.; Tippie, J. W. (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 6, 1839-49(Jun 1972).

The elastic scattering of ^{16}O from ^{18}O was measured in the c.m. energy range 13 to 33 MeV. The measurements include angular distributions at $E_{c.m.}$ = 21.1, 23.7, 26.4, and 29.0 MeV and excitation functions at $\theta_{c.m.}$ = 50, 60, 70, 80, 90, and 100°. Data were analyzed with the conventional optical model with the aid of both strongly and weakly absorbing potentials as well as an absorptive potential obtained from the matter distribution of the colliding ions. The principal result is that the potential must be transparent (weakly absorbing) for surface partial waves. The detailed behavior for the low-l partial waves is not well defined. (11 figures, 1 table) (auth)

39823 PHOTON SPECTRA FROM RADIATIVE ABSORPTION OF PIONS IN NUCLEI. Bistirlich, J. A.; Crowe, K. M.; Parsons, A. S. L.; Sharek, P.; Truoel, P. (Univ. of California, Berkeley). Phys. Rev., C; 5: No. 6, 1867-83(Jun 1972).

The photon spectra following capture of stopped pions in ^{4}He, ^{12}C, ^{16}O, ^{24}Mg, and ^{40}Ca were measured for photon energies between 50 and 160 MeV. A pair spectrometer was used, and a resolution of 2.0 MeV (full width at half maximum) was achieved. On the basis of several thousand events for each spectrum, collective excitation in the residual nucleus for capture by ^{4}He, ^{12}C, and ^{16}O was observed. Such excitation is predicted theoretically, and in some cases the detailed comparison with the data is good. For ^{24}Mg and ^{40}Ca, no significant structure is seen. In addition, the transition rates to particle–stable states in ^{16}O and ^{12}C were measured. A continuum background consistent with a direct-reaction mechanism was also observed for all the elements studied except for ^{4}He. Results for the pion-capture rates in CH_2 and H_2O are given. (10 figures, 4 tables) (auth)

39824 ELECTROMAGNETIC TRANSITIONS FROM THE ISOBARIC ANALOG STATES IN ^{13}C, ^{19}F, AND ^{31}P. Gunye, M. R.; Warke, Chindhu S. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., C; 5: No. 6, 1860-7(Jun 1972).

The recent experimental data on the decay of isobaric analog states in ^{13}C, ^{19}F, and ^{31}P to their low-lying normal-parity states are analyzed. The calculations are carried out in the framework of the Hartree–Fock projection method by considering all the nucleons in the configuration space of the first four major oscillator shells and employing a realistic nucleon–nucleon interaction. It is found that the calculated energy spectrum of ^{19}F, static moments, and $\Delta T = 0$ electromagnetic transition strengths in these nuclei agree very well with the experimental data. The $\Delta T = 1$ M1 transition strengths and the corresponding ft values calculated from the projected wave functions are also in good agreement with the experimental observations. The agreement for the $\Delta T = 1$ transitions between the present and the shell-model calculations is found to be nearly as good as that in the case of $\Delta T = 0$ transitions. (1 figure, 3 tables) (auth)

39825 ELASTIC SCATTERING OF LITHIUM BY CARBON. Poling, J. E.; Norbeck, E.; Carlson, R. R. (Univ. of Iowa, Iowa City). Phys. Rev., C; 5: No. 6, 1819-25(Jun 1972).

The elastic scattering cross sections for ^{6}Li and ^{7}Li on ^{12}C were measured at a number of bombarding energies from 4.5 to 13 MeV. The ratio of the cross section to the Rutherford cross section was determined for a wide range of angles at each energy. The data were fitted by an optical-model potential with four parameters: radius, diffuseness, real well depth, and imaginary surface-absorption well depth. All data for each isotope could be fitted with numerous sets of parameters with real well depths between 40 and 450 MeV. Data for both isotopes could be fitted using the same values for radius and diffuseness and essentially the same for real well depth, but with greater imaginary well depth for ^{7}Li. The fit holds good for all energies if a linear dependence of the imaginary well depth on energy is included. Data are also expressed in terms of the nuclear parts of the collision matrix elements which show certain regularities. As a by-product of this work, it was found that in the elastic scattering of lithium by gold the screening of the gold nucleus by its inner electrons is important for energies below 3.0 MeV. (5 figures, 4 tables) (auth)

39826 EFFECTIVE INTERACTIONS BETWEEN NUCLEONS IN THE s–d SHELL. Lee, T. Y.; Hsieh, S. T.; Yang, C. M. (National Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 5: No. 6, 2013-6(Jun 1972).

The effective interactions between nucleons in the s–d shells are investigated from an exact shell-model calculation via a least-squares fit of the experimental energy spectra of the normal-parity states in the ^{18,19,20}O, ^{18,19,20}F, and ^{20}Ne nuclei. The effects of the $d_{3/2}$ single-particle orbit in shell-model calculations of light s–d-shell nuclei are discussed briefly. The two-body matrix elements are compared with those calculated by Kuo and by Arima et al. (2 tables) (auth)

39827 PAULI BREAKUP OF DEUTERONS ON ^{16}O. Gambhir, B. L.; Griffin, James J. (Univ. of Maryland, College Park). Phys. Rev., C; 5: No. 6, 1856-60(Jun 1972).

To investigate the importance of the Pauli exclusion principle in reactions involving multinucleon systems, the problem of deuteron breakup on a recoilless nucleus is considered. After some simplifying assumptions, a solvable model problem is defined. Then a Hilbert–Schmidt integral equation is obtained for the breakup amplitude, in which the Pauli term is isolated. Corresponding Pauli-breakup cross sections are estimated for a model ^{16}O target. Interesting features of energy and angular dependence are discussed. (2 figures) (auth)

39828 INTERMEDIATE STRUCTURE AND THE PHOTODISINTEGRATION OF ^{16}O. Wang, Wayne, L. (Massachusetts Inst. of Tech., Cambridge).,; Shakin, C. M. Phys. Rev., C; 5: No. 6, 1898-1926(Jun 1972).

A theory of photonuclear reactions is formulated using a projection-operator formalism, and a T matrix describing a direct photoeffect and a resonance reaction is obtained. By introducing doorway and secondary-doorway states, the structure and energy dependence of the T matrix can be conveniently studied. The formalism is applied to the analysis of the photonuclear cross sections of ^{16}O. The (γ,n) and (γ,p) cross sections are calculated. Those channels are considered in which the residual nucleus is left in the ground state ($J^\pi = 1/2^-$) or the third excited state ($J^\pi = 3/2^-$). In the shell-model formulation, the doorways are taken to be mixtures of 1p–1h states, which are constructed in the Tamm–Dancoff approximation. The secondary doorways are assumed to be 3p–3h states, which are constructed in the interacting-boson approximation of Iachello and Feshbach. By mixing the doorways and the secondary doorways, a microscopic description of the compound states formed in the reactions is obtained. The doorways are shown to be responsible for the gross structure of the giant dipole resonances, while their couplings to the secondary doorways give rise to intermediate structure. A particular model of the 3p–3h states, together with certain simplifications in the description of the reaction, reproduces some of the experimental data (the photodisintegration to the $J^\pi = 1/2^-$ ground state) to a surprising degree of accuracy. The calculation evidently shows the importance of the 3p–3h admixture in the low-lying odd-parity states of ^{16}O. The results also give strong support to assigning E1 nature to the resonances at 21.0, 22.3, 23.1, 24.2, 25.2, and 25.6 MeV. (15 figures, 9 tables) (auth)

39829 STRENGTH OF THE ^{10}C → ^{10}B(2155 keV) β BRANCH. Goosman, D. R.; Alburger, D. E. (Brookhaven National Lab., Upton, N.Y.). Phys. Rev., C; 5: No. 6, 1893-7(Jun 1972).

A search for the β decay of ^{10}C to the 2155-keV level in ^{10}B was made in order to test the independent-particle-model predictions; mixed wave functions were used for the lowest two $J^\pi = 1^+$ levels in ^{10}B. In contrast to a previously reported value of $6.4 \pm 2.0 \times 10^{-5}$ per ^{10}C decay for this branch, these results limit the strength to $\leq 8 \times 10^{-6}$ with 90% confidence, and to $\leq 4 \times 10^{-6}$ with 50% confidence. Comparison of this result with the strength of the M1 transition between the 2155- and 1740-keV levels in ^{10}B shows that the ratio of orbital to spin contributions to the M1 matrix element exceeds 3.5. When the Cohen–Kurath wave functions for the first two $J^\pi = 1^+$ levels in ^{10}B are mixed in order to fit the strength of the 2155 → 1740-keV M1 transition, the predicted β branch to the 2155-keV level is at least 3 times as strong as the present experimental upper limit. (2 figures, 2 tables) (auth)

39830 $J^\pi = 7/2^+$ AND $11/2^+$, $T = 1/2$ STATES OF MASS 19. Garrett, J. D.; Hansen, Ole (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys.; A188: No. 1, 139-47(1972).

The properties of the $J^\pi = 7/2^+$ and $11/2^+$, $T = 1/2$ states of mass 19 are discussed in terms of Coriolis coupling between rotational bands based on the single-particle Nilsson configurations of the $N = 2$ oscillator shell. Single-nucleon-transfer spectroscopic factors are predicted for transitions leading to the positive-parity, $T = 1/2$ states of mass 19 and are compared with experimental results. It is found that the main feature of these states can be understood using s-d shell configurations. (2 figures, 5 tables) (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 38$

Refer also to abstracts 39563, 39568, 39811, 39823, 39824, 39826, 39842, 39844, 39866, and 39916.

39831 (PH–7) CASCADE DE-EXCITATION OF p-LEVELS IN EVEN–ODD NUCLEI WITH 21 A 41 AFTER THERMAL NEUTRON CAPTURE. Jafar, J. D.; Khalil, M. A.; Fawzia, A. H.; Demidov, A. M. (Atomic Energy Commission, Baghdad (Iraq). Nuclear Research Inst.). 1970. 22p. Dep. NTIS (U. S. Sales Only).

It is observed that the majority of p-levels with a large neutron width $\theta^2_{nn}(2J + 1)$ also have the largest reduced transition probability $(1_\gamma/E^3_\gamma)$ when decaying into the single-particle $2s_{1/2}$ neutron state. However, for $2p_{1/2}$ levels and other p-levels higher than $2p_{1/2}$ the largest reduced transition probabilities are observed for de-excitations into the $2p_{1/2}$ state. This enhanced M1 strength in comparison with E1 transitions, in the decay of p-levels, results from the predominantly single-particle character of p-states and the relatively simple nature of the M1 transitions involved where only the spin-orbit coupling is affected while the nuclear core undergoes slight re-arrangement. For example, in ^{29}Si the matrix elements of M1 transitions from the $2p_{1/2}$ level nearly equals the single-particle estimate, whereas the E1 transition into the $2s_{1/2}$ state is only 5.5×10^{-3} of the single-particle value. (auth)

39832 HALF-LIVES OF A FEW RADIONUCLEIDES. Lagoutine, F.; Legrand, J.; Perrot, Claudine; Brethon, J. P.; Morel, J. (CEN de Saclay, Gif-sur-Yvette, France). Int. J. Appl. Radiat. Isotop.; 23: No. 5, 219-24(May 1972). (In French).

The half-lives of the following eight radionuclides were determined by various methods, and the results are as follows: ^{33}P: 25.56 ± 0.07 days, ^{57}Co: 271.23 ± 0.63 days, ^{67}Cu: 61.83 ± 0.21 hr, ^{85}Sr: 64.68 ± 0.23 days, ^{89}Sr: 50.75 ± 0.25 days, ^{113}Sn: 115.07 ±

0.30 days, ^{134}Cs: 2.058 ± 0.012 years, and ^{192}Ir: 74.02 ± 0.18 days. These results are compared with the most recent and most exact values in the literature. Reference is made to the preparation and purity of each radionuclide. (auth)

39833 EVIDENCE FOR PROLATE SHAPE OF ^{32}S FROM 104 MeV α-PARTICLE SCATTERING. Schweimer, G. W. (Kernforschungszentrum, Karlsruhe, Ger.); Rebel, H.; Nowicki, G.; Hauser, G.; Loehken, R. Phys. Lett.; 39B: No. 5, 627-8 (29 May 1972).

The scattering of 104 MeV α-particles leading to the ground state and the first excited state of ^{32}S has been measured. A coupled channel analysis of the differential cross section results in a prolate shape for ^{32}S. (auth)

39834 HIGH-SPIN STATES IN ^{20}Ne AND THEIR POSSIBLE CLASSIFICATION INTO ROTATIONAL BANDS. Panagiotou, A. D.; Gove, H. E.; Harar, S. (Univ. of Rochester, N. Y.). Phys. Rev., C; 5: No. 6, 1995-2006(Jun 1972).

The reaction $^{12}C + ^{12}C \rightarrow \alpha_1 + ^{20}Ne^* \rightarrow \alpha_2 + ^{16}O_{g.s.}$ was employed in the measurements of the spin of highly excited states in ^{20}Ne. Coincidence angular correlations were obtained using two position-sensitive detectors. The spin and parity of four new levels were determined to be 9^- (15.18 ± 0.04 MeV), 5^- (15.9 ± 0.04 MeV), 8^+ (15.9 ± 0.04 MeV), and 7^- (18.10 ± 0.04 MeV). The two levels 5^- and 7^- may belong to the $K = 0^-$ band of the (86) SU_3 symmetry arising from three-particle core excitation, while the 8^+ level may be a member of the [220] "quartet" configuration. Results obtained from the $^{16}O(^6Li, d)^{20}Ne$ and $^{16}O(^7Li,t)^{20}Ne$ experiments are also presented and discussed. (13 figures, 2 tables) (auth)

39835 EFFECTIVE INTERACTIONS OF NUCLEONS IN THE UPPER s–d SHELL. Chiang, H. C.; Hsieh, S. T.; Lee, T. Y.; Wang, M. C. (National Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 5: No. 6, 2016-9(Jun 1972).

The effective interactions of the nucleons in the upper s–d shell are studied in a truncated shell-model calculation by a least-squares fit to the experimental energy levels of the normal-parity states in the nuclei ^{36}S, ^{36,37}Cl, ^{37,38}K, and ^{36,38}Ar. The resulting effective interactions and two-body matrix elements are discussed briefly. (2 tables) (auth)

39836 LIFETIME OF THE 5.69 MeV 5^- LEVEL IN ^{34}S. Greene, M Wayne (McMaster Univ., Hamilton, Ont.); Kuehner, J. A.; Ball, G. C.; Broude, C.; Forster, J. S. Nucl. Phys.; A188: No. 1, 83-8(1972).

The mean lifetime of the $J^\pi = 5^-$ level in ^{34}S at 5.689 MeV was measured using the recoil-distance Doppler-shift method. The result of $\tau_m = 54 \pm 5$ ps is consistent with the interpretation that this level arises predominantly from the $d_{3/2}-f_{7/2}$ configuration. (13 figures, 2 tables) (auth)

Nuclear Properties and Reactions, $39 \leq A \leq 58$

Refer also to abstracts 38502, 39568, 39811, 39823, 39831, 39832, 39866, 39886, 40180.

39837 (COO–3058-14) LINEAR ACCELERATOR PROJECT. Progress Report, January 1, 1972–March 31, 1972. (Rensselaer Polytechnic Inst., Troy N. Y.). [1972]. Contract AT(11-1)-3058. 34p. Dep. NTIS.

Research progress in neutron cross-section measurements and experimental and theoretical reactor physics and engineering is reported. Some previously unreported data is given on iron-filtered neutron beams, neutron elastic scattering in iron, neutron transmission and self-indication ratio measurements for uranium (γ,n) reactions with ^{57}Fe, and fast neutron transport in sodium. (J.W.R.)

39838 PROTON POLARIZATION DURING ELASTIC SCATTERING BY ^{51}V, ^{52}Cr, ^{53}Cr, ^{58}Ni, ^{59}Co, AND ^{60}Ni IN THE ENERGY RANGE 5.8 TO 6.5 MeV. Galakhmatova, B. S.; Kalacheva, Z. F.; Omar, M. R.; Romanovskii, E. A.; Sultan, M. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 506-11(Sep-Oct 1971). (In Russian).

The angular and energy dependence of proton polarization was measured for 5.8 to 6.5 MeV protons in elastic scattering by the nuclei ^{51}V, ^{52}Cr, ^{53}Cr, ^{58}Ni, ^{59}Co, and ^{60}Ni. Characteristic features of the measured angular distributions of polarization, and those averaged in the energy region 300 to 600 keV, are discussed. (tr-auth)

39839 L/K CAPTURE RATIO OF ^{49}V. Krahn, F.; Huster, E. (Univ., Muenster, Ger.). Z. Naturforsch.; 26a: No. 6, 1089 (Jun 1971). (In German).

The L/K capture ratio was determined for ^{49}V. Gaseous vanadium oxytrichloride was added to the argon-methane mixture of the counting gas. Measurements were conducted at pressures of 11 and 13 atm., respectively; the ratio PL/PK (^{49}V) = 0.106 ± 0.004 resulted. Application of Bahcall's exchange correction on the L/K capture ratios calculated by Brysk and Rose yielded too low a value for ^{49}V. Calculations with the wave functions of Band et al., however, yielded good agreement with the experiments. (H.B.G.)

39840 MASS NUMBER DEPENDENCE OF ACTIVATION CAPTURE CROSS SECTIONS FOR 14 MeV NEUTRONS. Kantele, J.; Valkonen, M. (Univ. of Jyvaeskylae, Finland). Phys. Lett.; 39B: No. 5, 625-6(29 May 1972).

Radiative capture cross sections of 14.5 MeV neutrons have been measured for several nuclei with an essentially improved activation method. The results agree with those from the spectrum method, which confirms that "shell effects" exhibited by earlier activation data are due to experimental errors. (auth)

39841 CALIBRATION OF THE ISOMER SHIFT OF ^{57}Fe. Rueegsegger, R.; Kuendig, W. (Univ., Zurich). Phys. Lett.; 39B: No. 5, 620-2(29 May 1972).

The influence of the chemical environment on the lifetime of the 14.4 keV state in ^{57}Fe was measured. The result together with Mössbauer measurements allowed to determine the change in the charge radius between the excited and the ground state as $\Delta R/R = -(3.1 \pm 0.6) \times 10^{-4}$. (auth)

39842 IMPORTANCE OF LARGE-ANGLE DATA IN OPTICAL-MODEL ANALYSIS OF HELION ELASTIC SCATTERING. Fulmer, C. B.; Hafele, J. C. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 5: No. 6, 1969-76(Jun 1972).

Optical-model analyses which include data far into the backward hemisphere for elastic scattering of complex projectiles at intermediate energies are found to produce optical potentials with many of the common ambiguities removed. Differential cross-section data with an extensive optical-model analysis are reported for 59.8-MeV helions elastically scattered from ^{27}Al and ^{52}Cr. The data include scattering angles back to 166° for ^{27}Al and to 149° for ^{52}Cr. Optical-model fits to these data are satisfactory only with a surface-peaked absorption term and with a spin–orbit term included in the potential. The discrete or family ambiguity in the potential is removed, and continuous ambiguities are notably suppressed. (12 figures, 2 tables) (auth)

39843 ORBITAL-ELECTRON-CAPTURE RATIOS IN THE DECAY OF ^{55}Fe. Pengra, J. G.; Genz, H.; Renier, J. P.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., C; 5: No. 6, 2007-12(Jun 1972).

The M/L and L/K orbital-electron-capture ratios in the decay of ^{55}Fe were determined by introducing the radioactive compound ferrocene-^{55}Fe into a multiwire, wall-less anticoincidence proportional counter as part of the counting gas mixture. The results are $P_M/P_L = 0.157 \pm 0.003$ and $P_L/P_K = 0.117 \pm 0.001$ at Z = 26. These values are compared with various theoretical predictions; and, together with previous experimental results on M/L capture ratios at low Z, they demonstrate that, of all the combinations of theoretical approaches, the Watson–Freeman wave functions with the exchange corrections of Vatai are the only ones which give good agreement with experiment at low Z. All other theoretical combinations lie considerably higher than experiment in the region below Z = 36. (4 figures, 2 tables) (auth)

39844 REACTION CROSS SECTIONS FOR 30- TO 60-MeV PROTONS ON VARIOUS ELEMENTS: COMPARISON OF THEORETICAL RESULTS WITH EXPERIMENT. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 5: No. 6, 2118-19(Jun 1972).

The theoretical reaction cross sections that were calculated using an intranuclear-cascade model were compared with recent experimental results for protons at 30, 40, 50, and 60 MeV on complex nuclei. Fifteen reactions were selected arbitrarily, and the agreement was found to be within 10% in all 15 cases. (1 figure, 1 table) (auth)

39845 LEVEL STRUCTURE OF ^{54}Mn. Dickens, J. K. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 5: No. 6, 1977-84 (Jun 1972).

Properties of levels in ^{54}Mn were studied using the reaction $^{54}Fe(n,p\gamma)^{54}Mn$. These data alone were not sufficient to determine spin and parity assignments; but, when they were correlated with data from prior experimental investigations of the ^{54}Mn nucleus, a set of unique J^π assignments for the lowest five excited states was determined. These assignments are consistent with nearly all presently available experimental data and are in good agreement with shell-model calculations. The level excitation energies and J^{π} values obtained are as follows: ground state, 3^+; 54.3 keV, 2^+; 156.9 keV, 4^+; 367.6 keV, 5^+; 407.5 keV, 3^+; and 839.0 keV, 4^+. Transitions from higher-lying states were observed, and possible J^{π} values were obtained. (1 figure, 2 tables) (auth)

39846 NUCLEAR SIZES IN $^{40\ 44\ 48}$Ca. Lombardi, J. C.; Boyd, R. N.; Arking, R.; Robbins, A. B. (Rutgers—The State Univ., New Brunswick, N. J.). Nucl. Phys.; A188: No. 1, 103-14(1972).

Differential-cross-section and analyzing-power angular distributions were measured for protons elastically scattered from ^{40,44,48}Ca at energies in the range of 10.8 to 16.3 MeV. Optical-model fits were used to obtain the rms radius of the real central potential for each nucleus and energy. Mean square radii of the neutron distributions were obtained from an expression which relates the mean square radii of the neutron and proton distributions, the real central potential, and the triplet and singlet nucleon—nucleon interactions. The differences in the rms radii for the neutron and proton distributions, $\langle r_n^2\rangle^{1/2} - \langle r_p^2\rangle^{1/2} = \Delta$, as determined in this analysis are +0.01 ± 0.14, −0.02 ± 0.12, and +0.39 ± 0.10 fm for ^{40,44,48}Ca, respectively. (5 figures, 3 tables) (auth)

Nuclear Properties and Reactions, $59 \leq A \leq 89$

Refer also to abstracts 39563, 39568, 39811, 39832, 39838, 39840, 39865—39867, and 39890.

39847 (IFA-CRD-49) LEVEL DENSITY DETERMINATION IN ^{55}Fe FROM EVAPORATION SPECTRA. Alevra, A.; Dumitrescu, R.; Lukas, I. R.; Magda, M. T.; Plostinaru, D.; Trutia, E. (Institutul de Fizica Atomica, Bucharest (Romania)). 1972. 8p. Dep. NTIS (U. S. Sales Only).

The energy level density in ^{55}Fe was determined by a statistical analysis of the neutron evaporation spectra from the ^{55}Mn(p,n) reaction. Neutron energy and angular distributions were measured at 10.8 MeV bombarding energy using a time-of-flight facility. The calculated level density in ^{55}Fe was compared with results determined in the ^{52}Cr(α,n) reaction. A good agreement was found. (J.W.R.)

39848 INELASTIC SCATTERING OF 14 MeV NEUTRONS BY MEDIUM WEIGHT NUCLEI. Fujita, Iwao; Sonoda, Masateru; Katase, Akira; (and others) (Kyushu Univ., Fukuoka). J. Nucl. Sci. Technol. (Tokyo); 9: No. 5, 301-9(May 1972).

Continuous spectra of neutrons inelastically scattered from Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ge and As have been measured at an incident energy of 14 MeV with good statistics. The time-of-flight technique was used. In the analyses there were used three sets of inverse-reaction cross section σ_I: (1) calculated with Perey—Buck potential, (2) with Bjorklund—Fernbach potential and (3) cross section assumed to be constant. The inverse-reaction cross section does not affect appreciably the values of nuclear temperature or nuclear level density parameter for these nuclei except Ti, V and Cr. The nuclear temperature was found to be nearly constant in the mass number region of 48 ~ 75. The level density parameter as a function of mass number follows the general trend suggested by Newton. Newton's coefficient is found to be 0.092, in agreement with values obtained in other experiments. The total inelastic scattering cross sections are derived. (auth)

39849 NOTE ON THE DECAY OF ^{60}Co. Legrand, J.; Clement, C. (CEN de Saclay, Gif-sur-Yvette, France). Int. J. Appl. Radiat. Isotop.; 23: No. 5, 225-7(May 1972). (In French).

Weak intensity transitions of ^{60}Ni in ^{60}Co decay were studied. In particular, it was proved that the peak observed at 821 keV is a simple escape peak. The intensity of the 2158 keV transitions was measured as $0.5 \pm 0.2 \times 10^{-3}$ percent. A decay scheme is proposed. (auth)

39850 MAGNETIC MOMENT OF THE FIRST EXCITED STATE IN ^{66}Ga. Heubes, P.; Johann, H. G.; Klinger, W.; (and others) (Univ. Erlangen, Ger.). Nucl. Phys; A188: No. 2, 417-22(1972).

The g-factor of the first excited state in ^{66}Ga (E_γ = 43.8 keV; $J^\pi = 1^+$) was measured by the DPAD method. The experimental value is g = −0.504 ± 0.009. A comparison with shell-model calculations for different configurations is carried out. A re-measurement of the half-life yields $T_{1/2}$ = 24.6 ± 2.0 ns. (auth)

39851 CALCULATIONS OF ISOMER RATIOS BASED ON THE STATISTICAL AND CASCADE-EVAPORATION THEORIES. Saha, G. B.; Yaffe, L. (McGill Univ., Montreal). Nucl. Phys.; A188: No. 2, 409-16(1972).

Calculations of isomer ratios for ^{87}Y arising from the reaction ^{89}Y(p,p2n)^{87}Y have been made in the energy range 30—85 MeV on the basis of the statistical and cascade-evaporation theories. The formalism of Huizenga and Vandenbosch has been used. The statistical theory calculation gives good agreement with experimental values of the isomer ratios up to 40 MeV if $\sigma_n^2 = 0.9\ I_r t/\hbar^2$. At higher energies the angular momentum distributions of cascade nuclei from the Vegas cascade calculations have been used as the initial spin distribution for isomer ratio calculations. The calculated isomer ratios have been weighted with different contributions of different modes of reactions leading to the formation of ^{87}Y isomers. The isomer ratios calculated on the basis of the cascade-evaporation theory compare reasonably well with the experimental values only if $\sigma_n^2 = 0.5\ I_r t/\hbar^2$. (auth)

39852 REMEASUREMENT OF B(E2; $0_2^+ \rightarrow 2_1^+$) IN ^{72}Ge BY COULOMB EXCITATION. Haight, R. C. (Univ. of Pittsburgh. Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 6, 1984-9(Jun 1972).

Bombardment of a thick germanium target with ^{16}O ions of 32 to 36 MeV excited the 691-keV (0_2^+) and 834-keV (2_1^+) states of ^{72}Ge. Observed yields of conversion electrons from the decay of these states were used to deduce B(E2; $0_2^+ \rightarrow 2_1^+$) = 1322 ± 241 e^2 fm^4. This result is compared with previous measurements where discrepancies have existed. An excitation function from 27 to 54 MeV was measured to indicate the energy region of pure Coulomb excitation of the 0_2^+ state. The importance of exciting the 0_2^+ state by transitions through higher-lying states including the giant dipole resonance is discussed. (3 figures,1 table) (auth)

39853 NEW NEUTRON DEFICIENT ISOTOPES OF RUBIDIUM. Velandia, J. A.; Holmes, W. I.; Boswell, G. G. J. (Univ. of Salford, Eng.). J. Inorg. Nucl. Chem.; 34: No. 2, 401-6 (Feb 1972).

^{77}Rb was produced by ^{63}Cu(^{16}O,2n)^{77}Rb and ^{59}Co(^{20}Ne,2n)^{77}Rb reactions. The half-life of ^{77}Rb is 6.1 ± 0.5 min as determined from the relative yields of ^{77}Kr obtained at 5 min intervals. The mass assignment was established by observing the growth and decay of the 280.0 keV transition in ^{77}Kr as well as chemical separation of the ^{77}Kr as a gas. Gamma transitions at 69.3, 87.6 and 155.4 keV are assigned to ^{77}Rb. The presence of ^{76}Rb with a half-life of 1.5 ± 0.1 min is inferred from gamma transitions of 171.6, 181.0 and 255.5 keV, together with the growth of the 360 keV gamma of ^{76}Kr. (auth)

39854 DISCOVERY OF ^{68}Se AND THE DECAY OF ^{68}As. Bilge, A. N.; Boswell, G. G. J. (Univ. of Salford, Eng.). J. Inorg. Nucl. Chem.; 34: No. 2, 407-11(Feb 1972).

^{68}Se was produced by the reaction ^{58}Ni(^{12}C,2n)^{68}Se using 54 MeV carbon ions bombarding enriched ^{58}Ni foils. The half-life of ^{68}Se is 3.2 ± 0.2 hr. The arsenic daughter ^{68}As was separated and found to have a half-life of 5.7 ± 0.4 min. The mass assignment was fixed by observation of gamma transitions due to ^{68}Ga in the separated selenium fraction 16 days after formation. A gamma transition at 0.98 MeV is assigned to ^{68}Se and transitions at 0.80, 1.08, 1.51, 2.00 and 2.71 MeV are assigned to ^{68}As. Position groups with E_{max} values of 0.77 and 1.48 MeV are assigned to ^{68}As. (auth)

39855 DISINTEGRATION OF ^{65}Ga TO ^{65}Zn. Basu, D. (Saha Inst. of Nuclear Physics, Calcutta). Nucl. Phys.; A188: No. 1, 97-102(1972).

The γ-ray spectrum from the decay of ^{65}Ga(15 min) was investigated using a Ge(Li) detector. Thirty-five γ rays were identified, of which the γ rays at 660, 703, 813, 1288, 1408, 1524, 1589, 1866, 1872, 1959, and 1965 keV are reported for the first time. From the energies and the intensities of the γ rays a level scheme accommodating all the γ rays is proposed with three new levels at 1524, 2077, and 2084 keV. Further evidence in support of the recently reported levels at 910, 1589, and 2419 keV was obtained. Possible spins and parities are assigned on the basis of the deduced log-ft values. (2 figures) (auth)

39856 DECAY OF ^{74}As. Van Hise, J. R. (Andrews Univ., Berrien Springs, Mich. Univ. of California, Livermore. Tri-State Coll., Angola, Ind.); Paperiello, C. Nucl. Phys.; A188: No. 1, 148-60(1972).

The decay of ^{74}As to levels in ^{74}Ge and ^{74}Se was studied using Ge(Li) detectors and a Compton-suppression spectrometer with a central Ge(Li) detector. Some coincidence data were also obtained using a Ge(Li) and a NaI(Tl) detector. The energies in keV, and relative intensities of the γ rays observed (in addition to the annihilation γ-ray), are 595.90 (100), 608.39 (0.92), 634.78 (24.8), 715.3 (0.014), 734.2 (0.0059), 867.0 (0.0088), 887.0 (0.043), 993.46 (0.035), 1101.1 (0.01), 1204.34 (0.46), 1269.6 (0.0031), 1602.1 (0.012), and 2198.1 (0.029). The 734.2- and 1269.6-keV γ rays were previously unobserved in the ^{74}As decay. The following excited states in keV, each with its probable spin and parity and log-ft value, are defined in ^{74}Ge: 595.90 (2+, 6.95), 1204.31 (2+, 8.20), 1463.3 (4+), 1482.90 (0+, 9.65), 1697.2 (3+, 9.90), 2198.1 (2+, 8.25). A Compton-suppression spectrometer was used to search for the possible zero-phonon 279-keV transition between the 0^+ state at 1482.90 keV and the 2^+ state at 1204.31 keV. Only an upper limit for its intensity can be reported of 0.0074 relative to 100 for the 596-keV γ ray. The low-lying levels of ^{74}Ge appear to be separable into a quasi ground rotational band and quasi β- and γ-vibrational bands; these are compared to such quasi bands in ^{72}Ge and ^{70}Ge. (6 figures, 1 table) (auth)

39857 GAMMA–GAMMA DIRECTIONAL-CORRELATION STUDIES IN ^{82}Kr. Satyanarayana, G.; Lakshminarayana, V. (Andhara Univ., Waltair, India). Nuovo Cim.; 9A: No. 2, 243-53(21 May 1972).

The gamma–gamma directional correlations on (698–777), (1318–777), and (618–1475) keV cascades in ^{82}Kr were studied with sum and sum-peak coincidence spectrometers. The values of the correlation coefficients for the (698–777), (1318–777), and (618–1475) keV cascades after correcting for background coincidences and solid angle are $A_2 = -0.265 \pm 0.011$, $A_4 = +0.292 \pm 0.012$; $A_2 = -0.022 \pm 0.008$, $A_4 = -0.070 \pm 0.010$; and $A_2 = +0.127 \pm 0.011$, $A_4 = -0.096 \pm 0.012$, respectively. The mixing ratios for the 698-keV ($2^+ \rightarrow 2^+$), 1318-keV ($3^+ \rightarrow 2^+$), and 618-keV ($3^+ \rightarrow 2^+$) transitions are -2.62 ± 0.23, -4.38 ± 0.23, and -2.09 ± 0.09, respectively. (auth)

Nuclear Properties and Reactions, $90 \leq A \leq 149$

Refer also to abstracts 38483, 38896, 38897, 39563, 39568, 39832, 39840, 39844, 39875, 39886, 39890, 39892, and 39904.

39858 (CONF-720701–1) TEST OF THE VALENCY MODEL OF NEUTRON CAPTURE IN ^{92}Mo + NEUTRON. Wasson, O. A.; Slaughter, G. G. (Oak Ridge National Lab., Tenn.). [1972]. 2p. Dep. NTIS.

For Presentation at conference on nuclear structure studies with neutrons; Budapest, Hungary (29 Jul 1972).

Resonant neutron capture ray spectra were measured in ^{92}Mo to test the Valency Model. The dominant strength of the primary rays feeding the ½+ first excited state suggests that p → s transitions are enhanced. (auth)

39859 (RLO–2227-T-14-1) NUCLEAR CHEMISTRY RESEARCH AT OREGON STATE UNIVERSITY. Annual Progress Report, September 1, 1971–August 31, 1972. Thomas, T. Darrah (Oregon State Univ., Corvallis. Radiation Center). 20 May 1972. Contract AT(45-1)-2227. 60p. Dep. NTIS.

Research progress is reported on: emission of α particles in fission, photoelectron spectroscopy, search for core electron satellites in CO, fluorinated benzenes, heavy-ion-induced nuclear reactions, and Moessbauer spectroscopy of fluorinated iodobenzenes. (M.C.G.)

39860 SOLUTION OF THE I = j-1 ANOMALY FOR ^{107,109}Ag IN THE ALAGA MODEL. Paar, V. (Univ. of Copenhagen. Inst. Rudjer Boskovic, Zagreb). Phys. Lett.; 39B: No. 5, 587-90 (29 May 1972).

The model of a three-hole proton cluster coupled to the quadrupole vibrational field (Alaga model) is applied to ^{107,109}Ag. The properties of the positive parity states are calculated in the parametrization found to give a very good description of the negative parity states (energy spectra, E2 and M1 transitions, static moments). (auth)

39861 DISTRIBUTION OF NUCLEONS IN THE NUCLEAR SURFACE FROM ELASTIC ALPHA-PARTICLE SCATTERING. Bernstein, A. M.; Seidler, W. A. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett.; 39B: No. 5, 583-6(29 May 1972).

Elastic scattering of α particles has been used to obtain information about the distribution of nucleons in the surface region. For ^{90}Zr and ^{208}Pb the neutrons are found to extend approximately 0.3 ± 0.1 fm beyond the protons. The results of this and of previous measurements for the RMS matter and neutron radii of ^{208}Pb are summarized and are in good agreement. (auth)

39862 GAMMA-RAY STUDIES OF THE DECAYS OF ^{92}Kr, ^{92}Rb, AND ^{92}Sr. Olson, R. J.; Talbert, W. L. Jr.; McConnell, J. R. (Iowa State Univ., Ames). Phys. Rev., C; 5: No. 6, 2095-2107(Jun 1972).

Measurements made with Ge(Li) detectors are reported for γ-ray transition energies and intensities observed following the β decay of the neutron-rich nuclei ^{92}Kr, ^{92}Rb, and ^{92}Sr. These nuclides are members of the isobaric decay chain for A = 92 beginning with ^{92}Kr, which was obtained using the on-line isotope-separator system TRISTAN developed for the study of gaseous fission-product activities. Level schemes were constructed for ^{92}Rb, ^{92}Sr, and ^{92}Y with the aid of Ge(Li)–Ge(Li) coincidence results. Some of the energy levels found are considered from a shell-model approach. (4 figures, 9 tables) (auth)

39863 INVESTIGATION OF α-DECAY OF ^{148}Sm RESONANCE STATES. Popov, Yu. P.; Przytula, M.; Rumi, R. F.; Stempinski, M.; Frontasyeva, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A188: No. 1, 212-24(1972).

By means of two large multisectional grid ionization chambers the yield of the ^{147}Sm(n,α)^{144}Nd reaction for neutron energies up to 230 eV was measured. The α-particle spectra from the decay of 14 resonances were obtained. The values of the total α widths or their upper limits were calculated for 24 resonances. The partial α widths of transitions to the ground and first two excited levels of the final nucleus and the spin of 10 resonances are given. A comparison of the partial and total α widths with statistical-model predictions was made. The prediction of the α-width distribution is reasonably consistent with the experimental one. This may be regarded as a confirmation of the Porter–Thomas assumptions concerning the distribution of partial α widths and the independence of fluctuations of the reduced α widths in the individual exit channels. An attempt was made to interpret some of the results obtained and their relationship to decay characteristics on the basis of the semimicroscopic description of high excited states proposed by V. G. Soloviev. (7 figures, 3 tables) (auth)

39864 STUDY OF THE LOW-LYING STATES IN ^{127}I THROUGH THE ^{127}I(n,n′γ) REACTION. Sinclair, D.; Montague, J. H. (Queen's Univ., Kingston, Ont.). Nucl. Phys.; A188: No. 1, 115-28(1972).

The γ decays from levels in ^{127}I populated in the (n,n′γ) reaction were studied with a Ge(Li) detector. Gamma-gamma coincidence spectra were obtained using a Ge(Li) detector together with a NaI(Tl) detector, which served both as the scattering sample and a γ-ray detector. The spectra were taken at a series of neutron energies from 0.5 to 1.6 MeV, during which successively higher energy levels were populated. Twenty-one levels up to 1444 keV were excited, and their energies and γ decays were measured. (9 figures) (auth)

39865 SEARCH FOR ^{92}Ru AND ^{64}Ge. De Jesus, A. S. M.; Neirinckx, R. D. (CSIR, Pretoria). Nucl. Phys.; A188: No. 1, 161-3(1972).

^{92}Ru was produced by means of the reaction ^{92}Mo(^{3}He,3n)^{92}Ru, and, after a rapid chemical separation, a value of $T_{1/2} = 3.9 \pm 0.2$ min was found for this nuclide. Attempts to identify ^{64}Ge produced in the reaction ^{64}Zn(^{3}He,3n)^{64}Ge and to determine its half-life were unsuccessful, and led only to the conclusion that $T_{1/2}$ is probably less than 20 s. (auth)

39866 OPTICAL-MODEL ANALYSES OF NEUTRON SCATTERING AT 8 MeV. Holmqvist B.; Wiedling, T. (Neutron Physics Lab., Studsvik, Sweden). Nucl. Phys.; A188: No. 1, 24-32(1972).

Fast-neutron elastic scattering angular distributions were measured for 22 natural elements, ranging from Al to Bi, at 8 MeV neutron energy. The experimental distributions are compared with distributions calculated by using an optical potential with spherical symmetry. An optimum description of the differential elastic scattering cross sections was calculated by varying five of the potential parameters with an automatic search routine. The real potential depth slowly decreases with mass number and neutron excess. This shows the existence of a potential term dependent upon isobaric spin. Its strength is 50 ± 10 MeV. The imaginary potential depth decreases for a nuclear mass number larger than about 55, while below this number it exhibits pronounced fluctuations. (4 figures, 2 tables) (auth)

39867 GROSS PROPERTIES OF DELAYED NEUTRON EMISSION AND β-STRENGTH FUNCTIONS. Pappas, A. C.; Sverdrup, T. (Univ. of Oslo, Blindern, Norway). Nucl. Phys.; A188: No. 1, 48-64(1972).

Delayed-neutron-emission probabilities and envelopes of kinetic-energy spectra of emitted neutrons for eleven odd-Z, odd-A precursors in the light-mass (A = 85 to 97) and heavy-mass (135 to 143) regions are studied theoretically by using a combined energy (i.e. Q^β, B^n) – angular momentum (i.e. J, π, l) approach. The main parameter studied is the β-strength function for which two extreme assumptions concerning its energy dependence are used, (i) that it is proportional to the level density in the emitter, and (ii) that it is constant above a given excitation energy and zero below. (The latter is known to govern delayed proton emission.) Comparison between calculated and measured probabilities (for all nuclides studied) and between estimated and observed envelopes of kinetic energy spectra (for three of the nuclides studied) favors β-strength functions having a strong energy dependence up to a region about one-half MeV above the neutron binding energy in the emitter followed by a weaker dependence beyond this energy region from which the β-strength functions seem to flatten out. (5 figures, 2 tables) (auth)

39868 (^{3}He,d) POPULATION OF ANALOG RESONANCES IN ^{93}Tc. Coker, W. R.; Zaidi, S. A. A. (Univ. of Texas, Austin). Nucl. Phys.; A188: No. 1, 65-71(1972).

By using proton form factors computed with a simple theory of analog resonances, recent data for the ^{92}Mo(^{3}He,d)^{93}Tc^A reaction to three prominent isobaric analog resonances (the $d_{5/2}$ at 8.39 MeV excitation, the $d_{3/2}-g_{7/2}$ triplet at 9.90 MeV, and the $h_{11/2}$(?) at 10.72 MeV) were fitted with DWBA. Spectroscopic factors resulting from the analysis are in reasonable agreement with those obtained from (d,p) reactions to the parent states in ^{93}Mo and from (d,n) reactions to the same analog resonances. (1 figure, 1 table) (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 38453, 39840, and 39866.

39869 (IFA-NR-9) MOESSBAUER ISOTOPE TABLES. Barb, D.; Morariu, M. (Institutul de Fizica Atomica, Bucharest (Romania)). 1972. 57p. Dep. NTIS (U. S. Sales Only).

Tables are presented on the decay schemes and other properties of isotopes used in Moessbauer studies A complete list of references is included. (J.W.R.)

39870 (USIP-72-6) COINCIDENCE MEASUREMENTS IN ^{175}Ta. Ohlsson, H.; Perrin, N.; Ader, B. (Stockholm Univ. (Sweden). Inst. of Physics). Apr 1972. 9p. Dep. NTIS (U. S. Sales Only).

Transition energy determinations and coincidence measurements on the decay ^{175}W → ^{175}Ta were performed at the Institut de Physique Nucléaire in Orsay, with high resolution Si(Li) detectors. The transition energies obtained were 14.97 ± 0.02 keV, 36.40 ± 0.02 keV and 51.38 ± 0.02 keV. With an 8 × 512 channel coincidence matrix the singles spectrum and coincidence spectra with the gates set on the 14.97 keV peak, the 51.38 keV peak, and the 36.40 keV peak were measured. (F.H.S.) (Sweden)

39871 SLOW NEUTRON RESONANCES OF RHENIUM. Ideno, Kazumi; Asami, Tetsuo; Nakajima, Yutaka; Ohkubo, Makio; Fuketa, Toyojiro (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 5, 261-7 (May 1972).

Neutron transmission measurements on natural rhenium were made in the energy region from 3 to 300 eV, using a LINAC neutron time-of-flight spectrometer. The resonance parameters of ^{185}Re and ^{187}Re were obtained below 120 eV by area and shape analyses based on the Breit–Wigner single level formula. Isotopic assignments of levels were taken from the data of other authors. The strength functions deduced are $(1.8 \pm 0.6) \times 10^{-4}$ for ^{185}Re and $(1.5 \pm 0.5) \times 10^{-4}$ for ^{187}Re. Correlations between level spacings were searched for and a series of equidistant levels was found in both nuclei. (auth)

39872 SPECTRAL FORM OF PARTICLES SCATTERED BY A THICK TARGET AND THE DETERMINATION OF ENERGY LOSSES. Sirotinin, E. I.; Tulinov, A. F.; Fiderkevich, A.; Shishkin, K. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 5, 541-6(Sep-Oct 1971). (In Russian).

The spectral form of particles which are scattered by a thick target was investigated as a function of the geometry of the experiment. The results of the calculation are compared with measured proton spectra where 6.3 MeV protons were scattered by a thick tungsten target. The value of dE/dx was evaluated from the measured spectra. (tr-auth)

39873 EFFECT OF LEVEL STRUCTURE ON THE INTENSITY OF PARTIAL RADIATIVE TRANSITIONS IN THE ^{155}Gd(n,γ)^{156}Gd RESONANCES. Danelyan, L. S.; Kardon, B.; Sotnikov, S. K. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 4, 1228-30(Apr 1972). (In Russian).

Intensities of the partial radiative transitions in resonances of the ^{155}Gd(n,γ)^{156}Gd reaction are studied by means of a Ge(Li)-spectrometer. The correlation observed between the widths for transitions to levels of the ground rotational band and the reduced neutron widths are discussed from the viewpoint of the semimicroscopic nuclear model. (auth)

39874 STRUCTURE OF LOW-LYING ROTATIONAL BANDS IN THE NUCLEUS ^{170}Tm. Ogle, W.; Wahlborn, S.; Ryde, H. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A188: No. 2, 316-36(1972).

The data of the 1^- (ground state) and 0^- (first excited) rotational bands in ^{170}Tm are analyzed within the framework of a simple model where these bands are mixed by the Coriolis coupling. Due to the symmetry properties of the internal wave functions, the even-I and odd-I members of the 0^- band essentially act as two independent bands. The main intrinsic configuration is assumed to be $\frac{1}{2}^+ [411]_p \frac{1}{2}^- [521]_n$. The band-head energies, the Coriolis matrix elements, and the moments of inertia are overdetermined by a fit to the experimental energy levels. The transition data also give information about the band mixing, and in addition determine some of the intrinsic M1 and E2 matrix elements. For the intrinsic structure and the mixing of the bands, the result of the analysis shows satisfactory agreement with model calculations and with evidence from adjacent nucleides. The two relevant energy splittings are calculated with a residual neutron-proton interaction, taken to be given by a central, spin and exchange dependent potential with Gaussian shape. It was found that with such an assumption one can reproduce the observed energy splittings, although the available parameters are not uniquely determined from the data. (auth)

39875 NONSCHEMATIC RANDOM-PHASE-APPROXIMATION DESCRIPTION OF GAMMA VIBRATIONS IN THE RARE-EARTH NUCLEI. Hernandez, E. S. (Univ. of Buenos Aires); Plastino, A. Phys. Rev., C; 5: No. 6, 1888-93(Jun 1972).

γ-vibrational states in the rare earth region are studied within the framework of the random-phase approximation (RPA) by employing the surface δ interaction as the residual interaction. The calculations are performed without recourse to the schematic model. All terms in the interaction arising in the RPA matrix are taken into account. The results are compared with those obtained by considering only the particle–hole term and with experiment. It is seen that previous schematic calculations overestimate the extent of the RPA correlations. Agreement with experiment, however, is not significantly improved. (2 figures, 1 table) (auth)

39876 BEST-PARAMETER SEARCH IN ASYMMETRIC ROTOR MODELS. Abecasis, S. M.; Hernandez, E. S. (Univ., Buenos Aires). Nuovo Cim.; 9A: No. 2, 137-50(21 May 1972).

The Davydov model is analyzed by performing a least-squares fit to the experimental energy levels while varying the parameters simultaneously until an optimum adjustment is obtained. Special emphasis is put on the feasibility of the method proposed to explain the higher vibrational states. The best parameters and the predicted energy sequences are presented for some typical nuclei. The results show that energy levels of deformed nuclei can be reasonably well explained by the Davydov model. Comparison with other models is also made. The use of more realistic potentials in the phenomenological models is encouraged. (2 figures, 2 tables) (46 references) (auth)

39877 PROPERTIES OF LOW-LYING LEVELS IN THE EVEN PLATINUM NUCLEI (182 ≤ A ≤ 192). Finger, M. (Institut de Physique Nucleaire, Orsay, France); Foucher, R.; Husson, J. P.; (and others). Nucl. Phys.; A188: No. 2, 369-408 (1972).

Decay properties of neutron-deficient even-mass Au isotopes obtained from the decay of on-line mass-separated Hg isotopes are presented. New information on energies, spins, parities and transition probabilities concerning low-lying states in even Pt isotopes is given. The experimental data are compared with the available theoretical predictions. (auth)

39878 DE-EXCITATION OF RARE-EARTH COMPOUND NUCLEI FORMED IN BOMBARDMENTS WITH 40 MeV α-PARTICLES. Ferguson, S. M. (Univ. of Washington, Seattle); Ejiri, H.; Halpern, I. Nucl. Phys.; A188: No. 1, 1-23(1972).

The intensities of ground-band transitions (including some new ones) and of other strong lines were measured for light doubly even residual nuclei produced in bombardments of rare earth targets with 40-MeV α particles. The well-known isomers of spin 6^+ and 8^-, which occur in the heavier rare earths, were found to be populated with great intensity (up to 40% of the total cross section). Aside from effects arising from these isomers, the ground-band intensities were found to decrease almost linearly with increasing spin of the emitting state. A small fraction of the intensity of ground-band lines of low spin was found to appear after a delay (≈30 ns) following the beam burst of incident particles. These and other features of the observations are interpreted in terms of a simple model for the compound-nucleus decay which emphasizes the role of rotational transitions in a narrow energy region which lies just above the energy gap. (6 figures, 2 tables) (auth)

39879 EXCITED STATES IN ^{171}Yb IDENTIFIED BY THERMAL NEUTRON CAPTURE REACTIONS. Wallander, E.; Selin, E. (Chalmers Univ. of Tech., Goteborg). Nucl. Phys.; A188: No. 1, 129-38(1972).

Energies and intensities of γ rays following thermal-neutron capture by enriched ^{170}Yb were measured using an internal target and three-crystal Ge(Li) pair and anti-Compton spectrometers. The reaction Q value was deduced, and a number of new excited states were found. A decay scheme for the low-lying levels is presented with spin and Nilsson assignments. (4 figures, 4 tables) (auth)

Nuclear Properties and Reactions, $190 \leq A \leq 219$

Refer also to abstracts 39825, 39832, 39844, 39861, 39866, 39877, and 39907.

39880 (LUNP-7204) HIGH ENERGY PHOTOFISSION IN GOLD AND LEAD. Kroon, I.; Forkman, B. (Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics. Lund Univ. (Sweden). Dept. of Physics); Tesch, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Apr 1972. 26p. Dep. NTIS (U. S. Sales Only).

The photofission cross section per equivalent quantum and the forward-to-backward ratios of gold and lead have been measured in the bremsstrahlung energy range 0.96 – 7.4 GeV using glass detectors. The experimental data are analyzed using data from an earlier lower energy experiment done at Lund with the same experimental technique. It is verified that the fission cross sections for the two target elements are almost constant above 1 GeV. From the moderate dependence of the forward-to-backward ratio on photon energy it is concluded that the excitation energy of the fissioning nucleus and the momentum transferred to it are rather independent of photon energy. The forward momentum deposited at the instant of fission is shown to increase only slowly, decreasing from 40% to 10% of the compound nucleus value in the energy interval studied. (auth) (Sweden)

39881 (LUNP-7205) ENERGY DISTRIBUTION OF FRAGMENTS FROM THE PHOTOFISSION OF ^{197}Au USING GLASS DETECTORS. Kroon, I. (Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics. Lund Univ. (Sweden). Dept. of Physics). Apr 1972. 17p. Dep. NTIS (U. S. Sales Only).

The kinetic energies of photofission fragments from ^{197}Au exposed at a bremsstrahlung end-point energy of 700 MeV have been measured using soda-lime glass detectors. The diameters of the fragment tracks were measured for fission fragments hitting the detector surface at normal angles of incidence. The glass detectors were calibrated with a ^{252}Cf source. The ^{252}Cf track diameter distribution was found to agree well with reported pulse height distributions from fragment kinetic energy studies using Si-surface barrier detectors. The track diameter distribution of photofission fragments in ^{197}Au was found to be symmetric. The measured mean fragment kinetic energy was found to be 70 MeV and the full width at half maximum of the photofission mass distribution is concluded to be less than 40 mass units. (auth) (Sweden)

39882 STRONGLY DEFORMED NUCLEI NEAR THE MAGIC PROTON SHELL 82. Faessler, A. (Kernforschungsanlage, Juelich, Ger.); Goetz, U.; Slavov, B.; Ledergerber, T. Phys. Lett.; 39B: No. 5, 579-82(29 May 1972).

The sudden change of the isotope phase shift in the Hg isotopes is explained by studying the deformation energy with the Strutinsky shell correction method. It is shown that going from the spherical isotope ^{204}Hg to the isotope ^{184}Hg a small negative deformation (up to $\beta_2 = -0.19$) is built up. Between the mass numbers 186 and 182 the deformation is shifted through the γ instability valley to larger positive deformations ($\beta_2 \approx 0.3$). The experimentally observed anomaly can be explained with the theoretical isotope shift constant, if this change of ground state deformations is taken into account. (auth)

39883 SINGLE-PARTICLE FRAGMENTS IN ^{205}Hg. Paar, V. (Univ. of Copenhagen. Inst. Rudjer Boskovic, Zagreb). Phys. Lett.; 39B: No. 5, 591-3(29 May 1972).

Single-particle fragments in ^{205}Hg are discussed in terms of coupling single-particle and collective degrees of freedom. (auth)

39884 COULOMB BREAKUP OF ^{6}Li. Ost, R.; Speth, E.; Pfeiffer, K. O.; Bethge, K. (Univ., Heidelberg). Phys. Rev., C; 5: No. 6, 1835-9(Jun 1972).

Measurements of the Coulomb breakup of ^{6}Li were performed in the energy range of the incident particle from 19 to 26 MeV. From the analysis of the deuteron component only, an almost constant B(E2) value about 55 e^2 fm^4 was deduced. (4 figures, 1 table) (auth)

39885 DECAYS OF THE EVEN–EVEN LEAD ISOMERS: ^{202m}Pb AND ^{204m}Pb. Guile, Jean; Doebler, R. E.; McHarris, Wm. C. (Michigan State Univ., East Lansing). Phys. Rev., C; 5: No. 6, 2107-17(Jun 1972).

The decays of the 9$^-$ isomers, ^{202m}Pb and ^{204m}Pb, were investigated using Ge(Li) detectors in a variety of singles and coincidence configurations. Improved conversion coefficients were obtained for two of the transitions following the decay of ^{204m}Pb, but no new, weak transitions were seen. Considerable improvement and enlargement of the ^{202m}Pb decay scheme was possible. Unambiguous multipolarity assignments were made for 15 of the 18 transitions following its decay, and all 18 were placed in a consistent decay scheme. States in ^{202}Pb were established (following the 90.5% isomeric-transition decay) at 0 ($J^\pi = 0^+$), 960.70 (2^+), 1382.82 (4^+), 1623.1 (4^+), 1915.2 (4^+), 2040.3 (5^-), and 2169.8 keV (9^-). Those in ^{202}Tl (following the 9.5% electron-capture decay) lie at 0 (2^-), 490.47 (4^-), 950.19 (7^+), 1098.7 (6^+, 7^+, 8^+), 1340.1 (8^+), 1552.1 ($8^+[9^+]$), and 1675.6 keV (9^+, 8^+). Interpretation is made concerning the nature of the states in ^{202}Pb and even–even Pb isotopes—and also in ^{202}Tl and odd–odd Tl isotopes—on the basis of the simple shell-model plus pairing forces. (5 figures, 6 tables) (auth)

39886 NUCLEAR SPECTROSCOPY OF ^{18}O, ^{42}Ca, ^{92}Zr, AND ^{210}Pb. Watson, C. E.; Wright, D. (Univ. of Texas, Austin). Nucl. Phys.; A188: No. 1, 33-40(1972).

Shell-model calculations were performed for ^{18}O, ^{42}Ca, ^{92}Zr, and ^{210}Pb by using a modified form of Green's velocity-dependent potential as the residual interaction. It was found that the spacing of low-lying levels can be predicted provided the central singlet-even part of the interaction is renormalized in a regular manner to simulate core excitation. (2 figures, 3 tables) (auth)

Nuclear Properties and Reactions, $A \geq 220$

Refer also to abstracts 38329, 38482, 38579, 39063, 39104, 39111, 39811, 39896, 40450, and 40455.

39887 (AERE-R-6555) ANOMALOUS EFFECT OF CHANGE OF NEUTRON SPECTRUM ON MASS YIELDS IN ^{239}Pu NEUTRON FISSION. Cuninghame, J. G.; Goodall, J. A. B.; Willis, H. H. (Atomic Energy Research Establishment, Harwell (England)). May 1972. 18p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

Radiochemical measurements were made of mass yields of eleven nuclides distributed over the whole mass range for fission of ^{239}Pu by neutrons whose spectra were tailored to resemble that of both DFR and PFR fast reactor core centers. It was found that large changes in yields (by about a factor of two) in the direction opposite to that which would be expected by naive systematic estimates occurred in those nuclides where the breaking of stable cores in the fissioning nucleus is required, i.e. in the valley and wings of the mass-yield curve. From the results it can be estimated that reductions of perhaps 0.3% in the actual yields (i.e. a change of –5%) might be expected at the top of the mass peaks. (auth)

39888 (BNL-tr-482) INVESTIGATION OF THE SPECTRA OF γ-RAYS LEADING TO THE PRODUCTION OF SPONTANEOUSLY FISSIONING ^{236}U ISOMER. Gangrskii, Yu. P.; Dalkhsuren, B.; Markov, B. N.; Nad, T.; Laitai, A.; Vinnai, I.; Ieki, L.; Kluge, G. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. J.), from report JINR-P15-6147. 13p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 26: 21851.

39889 (CONF-720607-5) IMPROVED ^{238}U RESONANCE PARAMETER EVALUATION FOR ENDF/B VERSION III. Durston, Colin [(Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.)]. [2 Feb 1972]. Contract AT(11-1)-3045. 5p. Dep. NTIS.

From eighteenth annual American Nuclear Scoeity conference; Las Vegas, NV. (18 Jun 1972).

A form of regression analysis was used in an evaluation of ^{238}U resonance parameters in which systematic differences were reduced before means were calculated. (J.W.R.)

39890 (COO-1505-53) DEEXCITATION PROCESSES IN NUCLEAR REACTIONS. Progress Report, May 1971–April 1972.

Porile, Norbert T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). May 1972. Contract AT(11-1)-1505. 32p. Dep. NTIS.

Research progress for the period May 1971 through April 1972 in the areas of high- and intermediate-energy nuclear reactions is reported. The high-energy reaction studies include charge dispersion and recoil measurements for 11.5-GeV proton reactions with ^{238}U and cross-section measurements for 11.5-GeV proton reactions with silver. The intermediate-energy studies include (p,p′) and (p,α) reactions on ^{62}Ni and ^{63}Cu induced by 14-MeV protons. These results were compared with spin and isospin dependent statistical theory. (J.W.R.)

39891 HEAVY ION RESEARCH AT DUBNA. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 9-15(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

The history of work at Dubna is briefly reviewed, including the production and identification of new elements. Work in progress toward the production of elements heavier than 105 is described. Xe was accelerated to energies well above the Coulomb barrier for U by running the two Dubna cyclotrons in sequence; a Xe^{30+} beam was accelerated to an energy of 900 MeV. A search for the superheavy elements analogous to Ir through Bi was negative: the cross section for the production of superheavy elements with a half-life of more than one hour and less than 10 days was found to be less than 0.1 μb. (14 figures, 1 table) (R.W.R.)

39892 ANGULAR MOMENTUM OF PRIMARY PRODUCTS FORMED IN THE SPONTANEOUS FISSION OF ^{252}Cf. Wilhelmy, J. B. (Univ. of California, Berkeley); Cheifetz, E.; Jared, R. C.; (and others). Phys. Rev., C; 5: No. 6, 2041-60(Jun 1972).

The measured intensities of intraband cascading transitions in the ground-state bands of 21 high-yield even–even fission products were analyzed by two methods to determine the magnitude of the intrinsic angular momentum of the primary products formed in the spontaneous fission of ^{252}Cf. The first method was to compare quantitatively the intensities of the intraband transitions observed in fission with those reported in the literature for in-beam (particle, xn) reactions for which the primary angular-momentum distribution was determined by optical-model calculations. The second method was based on a simple statistical-model analysis of the angular momentum distribution throughout the neutron evaporation and the pre-ground-state-band γ-ray transition phases of the deexcitation process. The two methods gave reasonably similar results, with the former method yielding a somewhat larger primary angular momentum for the fragments. The general conclusions from the statistical-model analysis are as follows: the average angular momentum of the products is $l \approx (7 \pm 2)\hbar$; the heavy fission products have ≈ 20% greater angular momentum than the light products; the more symmetric the mass division, the lower the initial angular momentum; and there are only small changes in angular momentum $[\sim(1-2)\hbar]$ with changes in fragment kinetic energy. An important feature of these results is that the fragment angular momentum does not correlate with the number of neutrons evaporated by the fragment. Additional measurements were made to study the angular distribution of individual prompt γ rays. In all observed cases the $2^+ \rightarrow 0^+$ ground-state transitions were forward-peaked with respect to the fission axis, and this is consistent with the assumption that the angular momentum is aligned in a plane perpendicular to the direction of fission. The results are discussed in terms of a quasi-statistical model in which the neck width at scission is approximately constant. (13 figures, 6 tables) (auth)

39893 THEORETICAL STUDY ON SCISSION CONFIGURATIONS OF FISSIONING ^{240}Pu AND ^{242}Pu. Noerenberg, W. (Univ., Heidelberg). Phys. Rev., C; 5: No. 6, 2020-30(Jun 1972).

The scission configuration is described by two interacting fragments in a single-particle model with pairing correlations, and studied as a function of two parameters. One parameter is the distance between the fragment centers of mass, and the other parameter is the mass ratio of the two fragments. The scission-point region can be conveniently studied in this molecular model, particularly because extensive knowledge about the fragment structure is incorporated. Level schemes, equilibrium deformations of the fragments, total energies, and charge distributions are studied for the compound systems ^{240}Pu and ^{242}Pu. The scission configurations are characterized by an approximate cancellation of the attractive nuclear force and the repulsive Coulomb force between the fragments. The proton number of the fragments turns out to be a rather good quantum number at scission. The results support the existence of a potential barrier at the scission point (scission barrier). It is shown that the calculated energies of the scission configurations can account for the asymmetry in the fragment-mass yield with its maximum at the heavy-fragment mass $A_1 \approx 140$. The decrease of the total energy for $A_1 \approx 140$ is due to single-particle states which have a small angular-momentum component along the symmetry axis and—because of their prolate density distribution—give large contributions to the binding energy between the fragments. The 50-proton shell closure has its greatest influence on the scission configuration around $A_1 = 130$, whereas the 82-neutron shell closure is most effective around $A_1 = 135$. (6 figures) (auth)

39894 LEVEL SCHEME OF ^{235}U AND THE DISTRIBUTION OF SINGLE-PARTICLE STRENGTH IN ITS EXCITED STATES. Rickey, Frank A. (Los Alamos Scientific Lab., N. Mex. Purdue Univ., Lafayette, Ind.); Journey, E. T.; Britt, H. C. Phys. Rev., C; 5: No. 6, 2072-95(Jun 1972).

The spectra of low-lying states of ^{235}U were studied using the reactions $^{233}U(t,p)^{235}U$, $^{235}U(d,d')^{235}U$, $^{234}U(d,p)^{235}U$, $^{236}U(d,t)^{235}U$, and $^{234}U(n,\gamma)^{235}U$. By using intensity ratios and angular distributions from the charged-particle reactions, primary γ-ray excitations, patterns of γ-ray deexcitations, and rotational-band systematics, 80% of the levels observed up to 1500 keV were assigned to 23 individual rotational bands. Some of the rotational bands can be associated with expected single-particle excitations, but in many cases it is shown that the single-particle strength is fragmented, this fragmentation giving rise to several rotational bands with similar properties. Mechanisms for this fragmentation are discussed, and the distribution of single-particle strength over the states observed is examined and compared with theoretical predictions. The neutron binding energy for ^{235}U is determined to be 5297.6 ± 0.5 keV. (16 figures, 7 tables) (auth)

39895 ANGULAR DISTRIBUTION OF ALPHA PARTICLES EMITTED IN THE FISSION OF ^{252}Cf. Rajagopalan, M.; Thomas, T. D. (Princeton Univ., N. J.). Phys. Rev., C; 5: No. 6, 2064-72(Jun 1972).

The angular distribution of α particles emitted in the spontaneous fission of ^{252}Cf was determined with respect to the light fragments and with respect to the heavy fragments. The full width at half maximum (fwhm) for the angular distribution of α particles is 23.5°—distinctly narrower than has been reported in the literature. The fwhm for the angular distribution of α particles emitted in coincidence with all the fragments is 37.5°. Trajectory and Monte Carlo calculations were done to find a set of initial parameters that give rise to an angular distribution and energy spectrum of α particles in agreement with experiment. The parameters so obtained were as follows: D is the interfragment distance at scission (21.5×10^{-13} cm); t is the time of emission of α particle (0.4×10^{-21} sec); E_0 is the average initial energy of α particle at scission (2 MeV); σ is the standard deviation in the initial position of α particle (2.5×10^{-13} cm). These parameters are contradictory to predictions of the statistical model. Furthermore, it was found that parameters given by the statistical model at fission lead to a calculated energy spectrum that is not in agreement with experiment. (7 figures, 1 table) (auth)

Nuclear Theory

Refer also to abstracts 39547, 39657, 39670, 39687, 39743, 39842, 39867, 39876, and 40186.

39896 (ANU-P-545) DIRECT REACTIONS TO MANY-CHANNEL, MANY-LEVEL FINAL STATES, AND AN EXAMPLE: (d,p) FISSION. Treacy, P. B. (Australian National Univ., Canberra. Research School of Physical Sciences). [1971]. 30p. Dep. NTIS (U. S. Sales Only).

The cross section for a direct reaction to a decaying final state is calculated using an R-matrix expansion for the final-state wave function. The theory is applied to a (d,p) reaction to a fissioning nucleus, with a simple two-centre fission model. Data from the $^{239}Pu(d,pf)$ process are fitted; the results imply that the usually-accepted two-hump potential shape may need modification. (auth)

39897 (CONF-720524-1) RESONANCE REACTION FORMALISMS FOR FISSILE NUCLEI. de Saussure, Gerard (Oak Ridge National Lab., Tenn.). 1972. 25p. Dep. NTIS.

From Cross Section Evaluation Working Group meeting; Upton, NY. (9 May 1972).

Some of the multilevel formalisms most frequently used to represent the low-energy cross sections of the fissile nuclei are very briefly described. Some of the properties and applications of the resonance parameters are also discussed. (auth)

39898 (CONF-720607-10) GENERAL FORMALISM FOR THE TRANSITION MATRIX OF NUCLEAR REACTION THEORY.

Perez, R. B.; Mockel, A. J. (Florida Univ., Gainesville). 1972. 6p. Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

A general formalism for the T-matrix was developed based on the use of Bloch's L-operator and invariant imbedding techniques. As an application of the formalism, a method for generating the Rapar–Peierls resonance parameters from a set of R-matrix parameters is illustrated. The main advantages of the formalism as compared to other resonance reaction theories are discussed. (J.W.R.)

39899 (IFA-NR-39) SOME REMARKS ABOUT THE DEPENDENCE OF THE AVERAGE REDUCED NEUTRON WIDTH ON THE NUCLEAR STRUCTURE. Aldea, L.; Stadnicov, T.; Mateiciuc, V.; Constantinescu, M. (Institutul de Fizica Atomica, Bucharest (Romania)). 1971. 7p. Dep. NTIS (U. S. Sales Only).

A systematic evaluation of average reduced neutron widths was performed. The A-, Z-, and N-number dependence of neutron widths and related strength functions is discussed. The implications concerning nuclear structure are pointed out. The evaluated average widths are compared with some model calculations. (J.W.R.)

39900 (IJS-R-605) G-MATRIX ELEMENTS FOR THE 1s, 1p, 1d, AND 2s SHELLS. Demos, J. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Jan 1972. 8p. Dep. NTIS (U. S. Sales Only).

G matrix elements derived from the Reid soft-core potential are presented for use in nuclear structure calculations in light nuclei. While every effort is made to keep the G matrix elements as accurate as possible, none of the higher order corrections are calculated, since these depend on the type of calculation the G matrix is used for. Only those corrections which arise from the use of an approximation of the exact Bethe–Goldstone equation were estimated. (auth)

39901 (LA-DC-72-543) TWO-NUCLEON TRANSFER AND SPHERICAL NUCLEI. Hansen, Ole (Los Alamos Scientific Lab., N. Mex.). [1972]. 39p. (CONF-720309-2). Dep. NTIS.

From Symposium on two-nucleon transfer and pairing excitations; Argonne, IL. (20 Mar 1972).

The features of (t,p) and (p,t) two-nucleon transfer reactions on spherical nuclei are discussed. These features include the selectivity and coherence of the reactions as well as the dependence of the cross section magnitude on the transfer orbits involved. Some of the experimental data on these reactions are reviewed. (J.W.R.)

39902 (LFEN-NI-72-a) PROGRAM FOR ANALYSIS OF ELASTIC NUCLEAR SCATTERING WITH THE OPTICAL MODEL. Fonseca, A. C. Sa (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1971. 33p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A program was developed for the calculation of the wave functions of the optical model. The program was written in ALGOL. The program calculates the differential cross sections of elastic scattering, the reaction cross section, and the polarizations resulting from the scattering of particles of spin 0, $\frac{1}{2}$, or 1, with or without charge for an optical potential. In all the calculations interactions with the spin of the nucleus was considered. The development of the program is outlined. (J.S.R.)

39903 (ORO-4317-2) POSSIBLE VALIDITY OF THE HARTREE–FOCK APPROXIMATION IN NUCLEAR PHYSICS. Technical Report No. 72-083. Miller, L. D. (Maryland Univ., College Park. Dept. of Physics and Astronomy). [1971]. 11p. Dep. NTIS.

Although non-relativistic estimates of single-particle kinetic energy expectation values appear to have invalidated the Hartree–Fock relation between total binding energy, single-particle eigenvalues, and kinetic energy expectation values, a recent relativistic Hartree calculation has been successful at reproducing finite nuclear properties for closed shell nuclei. Using the ^{16}O nucleus, it is demonstrated that this success is due to a reduction in the expectation values of the relativistic analog of the kinetic energy operator. (auth)

39904 ISOBARIC SPIN IN PHOTONUCLEAR REACTIONS. Kernel, G. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia. Univ., Ljubljana, Yugoslavia). Fizika (Zagreb); 4: No. 2, 97-111(Apr 1972).

Present evidence for isobaric spin splitting of the photonuclear giant dipole resonance is discussed with some examples. In particular, it is shown that the experiments on ^{11}B are inconclusive. For ^{90}Zr the ratio of integrated cross sections for the two isospin components is predicted, together with the corresponding ratio for some reaction channels. (auth)

39905 TWO-NUCLEON TRANSFER IN LIGHT NUCLEI. Kurath, D. Comments Nucl. Particle Phys.; 5: No. 2, 55-8 (Mar-Apr 1972).

It is stated that in the analysis of direct two-nucleon transfer nuclear structure and reaction theory are much more closely associated than in direct single-nucleon transfer. In the latter case the nuclear structure information is contained in the spectroscopic factor which is the square of the reduced matrix element of a single-nucleon operator between the target and final states. For two-nucleon transfer the nuclear structure information is contained in spectroscopic amplitudes. These are reduced matrix elements of a two-nucleon creation operator having angular momentum J and isospin τ evaluated between the target and final states. Among the matters discussed are: sum-rule for (p,t) or (n,^{3}He) reactions, and transfer with optical antisymmetry. (4 references) (UK)

39906 TOWARDS A MICROSCOPIC DESCRIPTION OF THE SCATTERING OF NUCLEONS FROM NUCLEI. Satchler, G. R. Comments Nucl. Particle Phys.; 5: No. 2, 39-46(Mar-Apr 1972).

It is stated that it has been customary to interpret data on the elastic scattering from nuclei of particles, especially nucleons, in terms of an average potential well—the optical model potential—whose shape, because of the short range of nuclear forces, is of the same general form as that of the nuclear density distribution. This is, however, in some ways an unsatisfactory approach; it is highly phenomenological, and it does not give any detailed insight into the mechanism of excitation or provide a link with detailed structure calculations of the nuclear states involved. Furthermore, it does not fit in with many experimental data for the excitation of states. It is very desirable to obtain an understanding of these interactions, starting from the nucleon-nucleon force, and in terms of the motions of individual nucleons within the target nucleus. Two features that have to be taken into account are the indistinguishability of the incident and target nucleons, and the very strong short range repulsive part of the nucleon-nucleon force; this is much too strong to use a perturbation theory. This is the same problem as encountered in nuclear structure studies, where the solution is to treat the scattering of any pair of bound nucleons as exactly as possible, while treating the influence of the remainder of the nucleus in an average way. In this way, the problem of a system of very strongly interacting nucleons is transformed into the problem of a system of nucleons interacting via an "effective interaction", or G-matrix, which even if not very weak is weak enough to make use of perturbation theory sensibly. Data on nucleon-nucleus scattering experiments are most abundant for energies up to a few tens of MeV, and in this low energy region it is reasonable to expect that the effective nucleon-nucleon interaction is quite similar to that for two bound nucleons. Recent effort has been directed towards finding how good an assumption this is by comparing its consequences with experimental results. Both elastic and inelastic scattering are considered, and reference is made to the spin and isospin dependences of the effective interaction. The theoretical basis of the approaches described is stated, however, to be not entirely satisfactory, but these approaches represent a big step forward from the phenomenological theories and open up the possibility of obtaining a large amount of structure information from scattering experiments. (17 references) (UK)

39907 DAMPING OF NUCLEAR DIPOLE STATES. Dover, Carl B. (Institut de Physique Nucleaire, Orsay, France); Lemmer, R. H.; Hahne, F. J. W. Ann. Phys. (N. Y.); 70: No. 2, 458-506(Apr 1972).

The connection between the photoabsorption cross section and the response of a system to a weak external electromagnetic field is exploited to study the absorption of γ-rays by nuclear systems. In the nuclear shell model, the response function is expressed in terms of the particle-hole excitations that are induced by the external field. The effect of collisions between excited particle-hole pairs and the nuclear background leads to a damping of such particle-hole excitations. It is shown that this damping can be reexpressed in terms of the individual damping widths of particles and holes in an interacting system. However, these damping widths have to be evaluated off the energy shell due to the requirement of energy conservation between eigenmodes of the ordinary shell model and the more complicated states that are responsible for their damping. The net effect of collisions is thus to replace the undamped particle-hole excitations of the shell model by damped quasiparticle-quasihole excitations, whose widths depend, however, on the excitation energy of the system. New dipole states are constructed out of such excitations and it is shown that the associated absorption cross section for γ-rays contains resonances at energies corresponding essentially to the dipole energies given by the ordinary shell model. However, the quasiparticle nature of the excitations introduces a new feature into the problem in that the new dipole states have a finite width. This width is determined by the average off-shell width of the quasiparticle-quasihole pairs at the excitation energy of each dipole state. The profile of the associated photoabsorption cross section is given by a sum of Breit–Wigner line shapes in a Tamm–Dancoff (TDA) calculation of the dipole excitations. If ground-state correlations are included via a random-phase-approximation (RPA) calculation, the profile of the resulting photoabsorption curve is approximately given by a sum of Lorentz, instead of Breit–Wigner line shapes. The dipole sum rules turn out to be the same in the ordinary shell model and its extension that includes quasiparticle damping. Since one does not have direct experimental access to the off-shell damping widths of individual particles and holes that are required in this description of dipole excitations, an attempt was made to infer this information from known optical model potentials for nucleon-nucleus scattering. Combining such a procedure with a schematic particle-hole model to simulate the shell-model ingredients required by this approach, the photoabsorption in ^{208}Pb was calculated. The model reproduces the main features of the experimental curve and with a width ranging from 2 to 5 MeV ($\Gamma_{exp} \simeq 4$ MeV) depending on which optical potential is used. In this connection it is essential to use optical potentials that are specific to ^{208}Pb and thus take into account the effect of shell closure on the absorptive part of the optical potential. The effect of an energy-dependent damping on the absorption curve is also illustrated in the schematic model. For instance a variation like $(\epsilon - \mu)^2$ in the quasiparticle widths (μ is the chemical potential) allows particle-hole excitations at lower energies to appear as fine-structure resonances while at the same time giving the correct width to the giant dipole state. Fine structure of a similar nature is found experimentally in ^{208}Pb. (auth)

39908 ISOTOPIC SPIN IN THE CONCEPT OF SECOND QUANTIZATION AND ANALOG STATES OF THE NUCLEUS. Vagradov, G. M. Kratk. Soobshch. Fiz.; No. 11, 14-20(Nov 1971). (In Russian).

Isobaric analog states relate to isospin in different nuclear processes, and also to transitions when a substitution of a proton for a neutron occurs in the excited state of a nucleus without change in other quantum characteristics. States being formed as a result of this may be observed in (n,p) reactions, in inelastic neutron scattering, in (π^-,π^0) charge exchange, and other processes. The concept of second quantization operator of neutron-proton and proton-neutron exchange without change in the remaining quantum numbers is developed. (K.S.W.)

39909 DIFFERENTIAL CROSS SECTIONS FOR ELECTRIC QUADRUPOLE COULOMB EXCITATION. I. Lea, Suzanne M. (Duke Univ., Durham, N. C.); Joshi, Vinaya; Lopez-Cepero, A. B. Comput. Phys. Commun.; 3: No. 2, 118-29(Mar 1972).

The DXS1 program calculates differential cross sections for Coulomb excitation of nuclei. The scattered charged particles are assumed to be structureless and all nuclear effects are ignored. The calculation follows the DWBA method closely. The program is in FORTRAN IV for the IBM 360/75 computer. (J.W.R.)

39910 COULOMB FUNCTIONS IN ENTIRE (η,ρ) PLANE. Bardin, C. (CEN de Saclay, Gif-sur-Yvette, France); Dandeu, Y.; Gauthier, L.; (and others). Comput. Phys. Commun.; 3: No. 2, 73-87(Mar 1972).

The COULOM program calculates the regular and irregular Coulomb wave functions and their derivatives for the entire (η,ρ) plane. It is useful for nuclear reaction and scattering studies involving heavy ions. COULOM is in ASA FORTRAN for the CDC 6600. (J.W.R.)

39911 FOUNDATION TO THE SHELL CORRECTION METHOD. Bunatian, G. G. (Moscow Physical Engineering Inst.); Kolomiets, V. M.; Strutinskii, V. M. Nucl. Phys.; A188: No. 2, 225-58(1972).

A foundation to the shell correction approach in studies of variations of nuclear masses and deformation energies is presented, based on the Hartree–Fock and the Fermi-liquid theories and on the local density approximation of the Brueckner–Bethe theory. In the first two cases the equations for the second order energy shell corrections and a relationship between the irregular component of the spatial density distribution and that of the shell model are obtained. The numerical results prove the rapid convergence of the shell correction expansion. Some technical problems involved in the calculation of first order corrections are considered. (auth)

39912 EFFECT OF THE Δ(1236) RESONANCE IN NUCLEAR MATTER AND IN THE TRI-NUCLEON SYSTEM. Green, A. M. (Laboratorium fuer Kernphysik, Zurich); Schucan, T. H. Nucl. Phys.; A188: No. 2, 289-315(1972).

It is shown that the inelastic process in which two nucleons scatter into a nucleon and a Δ(1236 MeV) can, in second order, contribute about 34 MeV/A attraction to the binding energy of nuclear matter. In the bound tri-nucleon system this implies that the probability of this process is comparable to the usual d-state probability. The effect of this is examined in the β-decay of the triton and the magnetic moments of ^{3}H and ^{3}He. A contribution to three-body forces is also discussed. (auth)

39913 PREDICTED LIMITS FOR PRODUCTION OF NEW PROTON-RICH NUCLEI BY A HEAVY-ION COMPOUND-NUCLEUS MECHANISM. Winn, W. G.; Gutbrod, H. H.; Blann, M. (Univ. of Rochester, N. Y.). Nucl. Phys.; A188: No. 2, 423-9(1972).

Evaporation calculations have been run for heavy-ion reactions leading to very proton-rich compound nuclei in the mass range 80 to 200. The maximum predicted product yields are shown, and the limits on the yields of very proton-rich nucleides are shown with respect to the proton drip line. Results of several sets of calculations for the production of superheavy elements are also presented. (auth)

39914 CORRELATIONS BETWEEN REDUCED PARTIAL ALPHA WIDTHS AND NEUTRON AND RADIATIVE WIDTHS IN NEUTRON RESONANCES. Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 39B: No. 5, 605-7(29 May 1972).

Cases are considered in which there may exist correlations between reduced partial alpha widths $\Gamma^0_{\alpha\lambda f}$ and reduced neutron widths $\Gamma^0_{n\lambda}$ in neutron resonances. It is shown that there may occur large correlations between $\Gamma^0_{n\lambda}$ for s-wave neutron capture by an even–even spherical nucleus and the alpha transition to the $j^\pi = 1/2^+$ state. Significant correlations between the alpha and gamma widths may be expected in the cases when alpha and E1 transitions proceed to the ground states of even–even nuclei as well as in the cases when alpha transition goes to the ground state and E1 transitions go to the one-phonon and two-phonon states. (auth)

39915 DO MULTINEUTRONS REALLY EXIST. Baz, A. I.; Bragin, V. N. (Inst. of Atomic Energy, Moscow). Phys. Lett.; 39B: No. 5, 599-600(29 May 1972).

It is argued, that nuclear multineutrons, if they exist at all, are heavy nuclei, which contain at least 100 neutrons. (auth)

39916 HARTREE–FOCK CALCULATIONS FOR α-TYPE (s,d)-SHELL NUCLEI WITH A SIMPLE EFFECTIVE INTERACTION. Krieger, S. J. (Univ. of Illinois, Chicago. Oak Ridge National Lab., Tenn.); Moszkowski, Steven A. Phys. Rev., C; 5: No. 6, 1990-4(Jun 1972).

Nuclear properties, such as ground-state energies, rms charge radii, and intrinsic quadrupole moments, are calculated using the Hartree–Fock method for self-conjugate even–even s–d-shell nuclei. The internucleon interaction is a spin-independent S-state version of the Skyrme interaction. The density dependence of the G matrix is simulated by a three-body repulsive δ interaction. The connection between the latter and a density-dependent two-body δ interaction is discussed. The results for binding energies and rms radii agree much better with experimental values than earlier calculations using a different, density-independent interaction. (2 tables) (auth)

39917 RECOIL EFFECTS IN ALLOWED NUCLEAR BETA DECAY. Holstein, Barry R. (Univ. of Massachusetts, Amherst); Shanahan, W.; Treiman, S. B. Phys. Rev., C; 5: No. 6, 1849-55(Jun 1972).

Model-independent results, correct to first order in recoil terms E/M, are given for various spectrum and correlation effects in allowed β decay with parent polarization and/or orientation and for β–γ circular-polarization correlations. (auth)

39918 USE OF ECKART INTERACTIONS IN DISTORTED-WAVE BORN-APPROXIMATION CALCULATIONS. Payne, G. L.; Von Behren, P. L. (Univ. of Iowa, Iowa City). Phys. Rev., C; 5: No. 6, 1955-68(Jun 1972).

The evaluation of the finite-range distorted-wave Born-approximation matrix elements is shown to be considerably simplified when one uses Eckart bound-state wave functions. The use of these wave functions to describe the stripping reaction ^{12}C(^{6}Li, d)^{16}O is found to give reasonable agreement with the experimental results. Also, the use of the Eckart interaction as a test of the various methods for the evaluation of matrix elements is demonstrated. (8 figures, 2 tables) (auth)

39919 FINAL STATE INTERACTIONS AND THE CHARGE DEPENDENCE OF $(\pi,\pi N)$ REACTIONS FROM NUCLEI. Robson, D. (Florida State Univ., Tallahassee). Ann. Phys. (N.Y.); 71: No. 1, 277-92(May 1972).

The theory of pion quasi-elastic scattering leading to nucleon emission from nuclei at pion energies near the (3,3) resonance energy is investigated. The importance of final state interactions between the outgoing nucleon and residual nucleus is studied with particular emphasis on the relative cross sections for the reactions $A(\pi^+,\pi N)$ and $A(\pi^-,\pi N)$ and also for the reactions $A(\pi^-,\pi^- n)$ and $A(\pi^-,\pi^- p)$ which produce mirror nuclei in the final state. A reasonably consistent description of the available data is obtained only if compound nucleus effects are included in the final state interaction. Using an isospin basis the remarkable deviations from the simple plane wave impulse approximation theory observed in several experiments are seen to arise from the complete coherence assumptions inherent in the plane wave approach. Predictions from the present approach are made for target nuclei with nonzero neutron excess for both ($\pi,\pi N$) and (π,π') processes. (auth)

39920 INDUCED-TENSOR AND SECOND-ORDER-FORBIDDEN TERMS. Holstein, Barry R. (Univ. of Massachusetts, Amherst). Phys. Rev., C; 5: No. 6, 1947-51(Jun 1972).

A model-independent result for the $\beta-\gamma$ correlation in allowed β decay is given, including all second-order-forbidden corrections. A suggested method for measurement of the first-class contribution to the induced-tensor form factor is discussed. (auth)

39921 G-MATRIX ELEMENTS FOR THE 1s, 1p, 1d, AND 2s SHELLS. Demos, J. (Univ. of Ljubljana, Yugoslavia). Nucl. Phys.; A188: No. 1, 41-7(1972).

G-matrix elements derived from the Reid soft-core potential are presented for use in nuclear structure calculations in light nuclei. While every effort was made to keep the G-matrix elements as accurate as possible, none of the higher-order corrections were calculated, since these depend on the type of calculation for which the G-matrix is used. Only those corrections which arise from the use of an approximation to the exact Bethe—Goldstone equation were estimated. (1 table) (auth)

39922 QUANTUM MECHANICAL TREATMENT OF PARTICLE TRANSFER BETWEEN HEAVY IONS NEAR THE COULOMB BARRIER IN THE PRESENCE OF COULOMB EXCITATION. Ascuitto, R. J. (Yale Univ., New Haven); Glendenning, Norman K. Nucl. Phys.; A188: No. 1, 185-92(1972).

The theory of particle transfer between heavy ions when Coulomb excitation of the ions can take place formulated quantum mechanically. It is pointed out that the large l and r spaces required for a quantum-mechanical treatment of Coulomb excitation alone are not required for transfer reactions even when the former process plays an important role. This makes the quantum description of the transfer process calculationally possible. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

39923 (TID-3557(1971 Suppl.)) CONTROLLED FUSION AND PLASMA RESEARCH. A Literature Search. Whitson, Milton O. (comp.) (Technical Information Center (AEC), Oak Ridge, Tenn.). Jan 1972. 483p. Dep. NTIS.

This search includes 2905 references on various aspects of plasma physics and controlled thermonuclear research. Report number, corporate author, and subject indexes are included. (auth)

39924 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 6, NO. 3, 1972. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 52p.

This listing contains 271 references on various aspects of the above subjects. (M.O.W.)

Confinement and Heating

39925 (IPP-6/105) ON THE ROLE OF AZIMUTHAL ELECTRIC FIELDS IN TOROIDAL TRANSPORT. Dum, C. T.; Pfirsch, D. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 16p. Dep. NTIS (U. S. Sales Only).

The role of azimuthal electric fields in toroidal transport is considered. A consistent kinetic theory is given for the collision-dominated regime, and this is compared with a fluid calculation. The weakly collisional and intermediate regimes are also discussed. (auth)

39926 HEATING OF A MOVING PLASMA BY A FAST MAGNETOSONIC WAVE OF LARGE AMPLITUDE. Voloshko, A. Yu.; Solodovchenko, S. I.; Chechkin, V. V. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1822-8(Nov 1971). (In Russian).

An experimental investigation of plasma heating by a strong rf field was made in the frequency range $\omega_{Hi} < \omega < (\omega_{He}\omega_{Hi})^{1/2}$ at $\omega_{pe} \gg \omega_{He}$. With resonance excitation of the "whistler" mode up to 70% of the energy stored in a shock-excited circuit was transferred to the plasma. Under these conditions, the plasma blob experienced a rapid ($\lesssim 1$ μsec) heating to $N(T_e + T_i) \sim 10^{15}$ eV/cm^3. A splitting of the excitation resonance due to Doppler effect was observed. During the motion of the hot blob along a dc magnetic field, the plasma is ~10% cooled at a distance of ~10 cm from the heating section. (auth)

39927 STOCHASTIC ACCELERATION OF PARTICLES. Akhiezer, A. I.; Bakai, A. S. (Kharkov State Univ.). Dokl. Akad. Nauk SSSR; 201: No. 5, 1074-7(11 Dec 1971). (In Russian).

The stochastic mechanism of an accelerated cosmic particle which experiences an uncorrelated thrust at the boundary of space is a partial case of a more general problem in the multidimensional movement of a dynamic system experiencing irregular impulses at the surface. The simplest case of a particle moving in a circle was investigated first, and subsequently the argument was extended to phase trajectory in a two-dimensional torus, then generalized for an N-dimensional dynamic system. The results were applied to surface high-frequency heating of a plasma in closed trap. (K.S.W.)

39928 ELECTRON HEATING IN A PERPENDICULAR COLLISIONLESS SHOCK. Cairns, R. A. (Univ. of St. Andrews, Scotland). J. Plasma Phys.; 6: No. 3, 443-8(Dec 1971).

A model is proposed to explain the observed electron heating in perpendicular collisionless shock waves. This relies on trapping of the electrons by the turbulent electric field to modify their orbits in such a way that they gain energy from the steady potential jump across the shock. With simple assumptions about the nature of this trapping, reasonable agreement with the experimentally observed heating is obtained. In addition, the model provides qualitative agreement with a number of other experimental observations. (auth)

39929 ION HEATING CAUSED BY ION ACOUSTIC WAVES IN AN ION-STREAMING PLASMA. Honzawa, T.; Kawai, Y. (Nagoya Univ., Japan). Plasma Phys.; 14: No. 1, 27-36(Jan 1972).

It is experimentally shown that ion acoustic waves are driven by streaming electrons and damped by streaming ions in an ion-streaming plasma, which results in ion heating because of some nonlinearities. The drift of electrons is controlled by changing the bias applied to a meshed grid immersed in the plasma. The results of this work indicate that, when the drift velocity of electrons is settled at a proper value, one can observe standing ion acoustic waves as well as the increase of ion temperature, and that there is a good correlation between the increase of ion temperature and the amplitudes of the ion waves. Explanation of the mechanism of ion heating is also described. (auth)

39930 MOTION OF TRAPPED PARTICLES IN A VINTOTRON. Nemov, V. V. (Physical-Technical Inst., Kharkov). Plasma Phys.; 14: No. 1, 37-52(Jan 1972).

The motion is investigated of particles trapped in the vacuum magnetic field of a vintotron, i.e., a plasma trap of the stellarator type with a spatial magnetic axis whose magnetic configuration consists of a strong longitudinal field, together with the field of helical windings plus that of a ring current, or of a strong longitudinal field, together with the field of helical windings with nonsymmetrical currents. Attention is chiefly devoted to the motion of particles trapped by inhomogeneities of the helical field. (auth)

Diagnostics

Refer also to abstract 39971.

39931 METHOD FOR DETERMINING STATIONARY ELECTRIC CURRENT DISTRIBUTION IN A PLASMA BASED ON NONLINEAR MAGNETIC CHARACTERISTICS OF A FERROMAGNETIC CORE. Sakao, Fujihiko (Hiroshima Univ.). Hiroshima Daigaku Kogakubu Kenkyu Hokoku; 20: No. 1, 1-8(Nov 1971). (In Japanese).

When a ferromagnetic core with nonlinear magnetic flux-field characteristics is subjected to a stationary field, together with a sinusoidal field, the second harmonic component is generated whose magnitude is a function of the stationary field strength. This phenomenon, occasionally used in a chopper for a dc amplifier, was employed to determine distribution of the steady-state current in a plasma. The feasibility of the method was established. As an example, blowing of current patterns due to wind was detected. Some of the difficulties in the practical measurement are pointed out, and ways of overcoming them are discussed. (auth) (Japan)

39932 RF SHEATH AND ADMITTANCE CHARACTERISTICS OF A SPHERICAL PLASMA PROBE. Kan, J. R. (Dartmouth Coll., Hanover, N. H.). Radio Sci.; 7: No. 2, 301-8(Feb 1972).

A radio-frequency sheath model for a spherical probe in a collisionless plasma is presented. The method of solution is based on the quasi-static approximation and the electrostatic probe theory of Bernstein and Rabinowitz. The resistive part of the admittance is ascribed to the sheath transit-time collisionless dissipation mechanism suggested by Mayer and developed by Gould. Expressions are obtained for the effective sheath thickness and the equivalent resistance of the transit-time dissipation. The sheath model and, hence, the admittance are completely determined in terms of the bias potential, the probe radius, the plasma frequency, and the Debye length; i.e., there are no adjustable parameters in theory that are to be determined by experiment. Results agree favorably with Cohen and Bekefi's experimental data on the conductance resonant frequency and the width of the conductance peak. (auth)

39933 IMPEDANCE CHARACTERISTIC OF A SPHERICAL PROBE IN AN ISOTROPIC PLASMA. Tarstrup, J.; Heikkila, W. J. (Univ. of Texas, Dallas). Radio Sci.; 7: No. 4, 493-502 (Apr 1972).

An experimental investigation of the impedance characteristic of a spherical plasma probe was carried out for a quantitative assessment of theoretical work, and of hydrodynamic or fluid theory in particular. A stable, low-temperature ($T \sim 500$°K) plasma was produced in nitrogen by a cold-cathode discharge, with a plasma frequency of the order of 15 MHz and with an electron collision frequency in the range of 10^6 to 10^7 sec^{-1}. The probe consisted of two hemispheres, one serving as a guard to eliminate the effects of the connecting leads; this geometry provided an almost purely radial electric field over the test hemisphere. Probe diameters ranged from 7 to 20 mm (10 to 30 Debye lengths). Hydrodynamic probe theory was tested against the experimental results for the specific cases corresponding to the probe at floating potential and at space potential. Good agreement was obtained for both the real and imaginary parts. The real part of the impedance shows a peak near the plasma frequency, a small shift being explicable in terms of realistic sheath profiles. Electron density can thus be deduced rather accurately, and electron temperature approximately, on the basis of hydrodynamic theory. Accurate values of the electron-neutral collision frequency were also obtained for plasmas where the collision frequency was larger than 0.4 times the radian plasma frequency. At lower pressures the presence of collisionless or Landau damping was clearly established, and the more accurate kinetic theory is necessary to explain the experimental results. (auth)

39934 DIAGNOSTIC TECHNIQUES FOR HIGH-TEMPERATURE PLASMA REACTIONS. Mullen, J. H.; Madson, J. M.; Medgyesi-Mitschang, L. N.; Peng, T. C.; Doane, P. M. Chem. Eng. Progr., Symp. Ser.; 67: No. 112, 74-84(1971).

A system was developed for the measurement of chemical kinetics in high-temperature plasmas. Plasma temperatures and electron densities were measured in the reaction region. Reaction temperatures from 1,000 to 3,000°K were attained. Direct measurements of reaction products, including both positive and negative ion species and free electrons, were achieved. Electron attachment rate constants for several electrophilic target molecules were calculated from the negative ion signals at a reaction temperature of 3,000°K. Additional experimental attachment studies will be necessary to extend the measured attachment rates over a broad temperature range for comparison with data obtained by other investigators. Preliminary results indicate that the electron attachment rates measured at 3,000°K can differ significantly from those measured at lower temperatures. (auth)

39935 DETERMINATION OF RADIAL DISTRIBUTION OF TEMPERATURE IN ARGON PLASMA JETS. Ionescu-Bujor, Th. (Inst. of Physics, Bucharest). Stud. Cercet. Fiz.; 24: No. 2, 235-52(1972). (In Rumanian).

A brief review of the literature for diagnostic methods for the above subject is presented. (38 references) (M.O.W.)

39936 SPECTROSCOPIC INVESTIGATIONS OF A LASER SPARK. IV. ABSORPTION SPECTRA IN HYDROGEN. Evtushenko, T. P.; Mkrtchyan, V. Kh.; Ostrovskaya, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 2049-55(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2581-9(Dec 1971).

The absorption spectra of a laser spark in hydrogen at a pressure of 6 atm are obtained. The continuum source is a laser spark in air. For times from 0.5 to 2.6 μsec, the plasma of a laser spark in hydrogen cannot be regarded as optically thin for Hα radiation. The absorption spectra are used to investigate the time variation of the temperature and density of the electrons and the atoms in the laser plasma. (auth)

39937 ELECTROSTATIC PROBE IN A NONSTATIONARY PLASMA. Novikova, K. P.; Ul'yanov, K. N. (Electrotechnical Inst., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1934-7(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2437-41(Nov 1971).

The relation between the ion probe current and the characteristics of a nonstationary plasma are determined. In a plasma in which volume recombination dominates, the relation between the ion probe current and the plasma characteristics depends upon nonstationary processes. The relation is different in the development and decay stages of the plasma. When volume recombination is not important the ion current to the probe is proportional to the density at any given time. (auth)

39938 SPACE POTENTIAL IN PROBE MEASUREMENTS. Lukovnikov, A. I.; Novgorodov, M. Z. (Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1931-3(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2433-6(Nov 1971).

The results of various investigations of the space potential in probe measurements are analyzed. Measurements of the electron density and collision frequency obtained by probe methods and high-frequency methods are compared. (auth)

39939 MEASUREMENT OF MAGNETIC FIELD IN A PLASMA WITH A CHARGED-PARTICLE BEAM. Kalmykov, A. A.; Timofeev, A. D.; Shevchuk, B. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1938-46(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2442-53(Nov 1971).

The possibility of measuring magnetic and electric fields in coaxial plasma systems with the E_r, E_Z, and H_φ field components is considered. The problem is solved analytically and by numerical methods for various field distributions. The magnetic-field distribution in a pulsed coaxial plasma accelerator was measured experimentally by means of proton and deuteron beams with energies of 10 to 40 keV. (auth)

39940 PULSED-HOLOGRAM INVESTIGATION OF GAS BREAKDOWN IN FRONT OF A LASER-PRODUCED PLASMA. Ashmarin, I. I.; Bykovskii, Yu. A.; Degtyarenko, N. N.; (and others) (Moscow Engineering Physics Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1881-7(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2369-77(Nov 1971).

Phenomena in air and helium at various pressures produced when a ruby laser is focused on lead, copper, and aluminum targets are investigated by pulsed holograms. The advantages of this technique are pointed out. The symmetry axis of the pulsed plasma produced at atmospheric pressure by an oblique laser beam does not coincide with the normal to the target surface. This phenomenon can be explained by local absorption of the energy of the laser beam at the plasma boundary. The plasma is observed to affect the breakdown of the gas in front of the target. This can be explained by the ionizing effect of ultraviolet emission from the plasma. A study of the dependence of this effect on the target material and the composition of the surrounding gas confirms this hypothesis. (auth)

Kinetics (General)

39941 (EUR-CEA-FC-640) CONTRIBUTION OF COULOMB COLLISIONS TO PLASMA RELAXATION IN THE DECA MIRROR MACHINE. Launois, D.; Lecoustey, P.; Tachon, J.; Kesner, J.; Chatelier, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1972. 36p. Dep. NTIS (U. S. Sales Only).

The relaxation of the ion distribution function was observed for a plasma ($n \simeq 10^{12}$ cm^{-3}, $\overline{E}_i = 200$ eV) confined in a circular, stabilized magnetic mirror well. Results of measurements were compared with the predictions of a Fokker–Planck computer code. The evolution of an initially skewed angular distribution function appeared to be in good accord with the theoretical model. However, the final anisotropy of the plasma was greater than the calculated one. (auth)

39942 (INR-P-1377) SCATTERING OF LASER LIGHT FROM A MARGINALLY STABLE HYDROGEN PLASMA. Infeld, Eryk; Skorupski, Andrzej; Zakowicz, Wladyslaw (Institute of Nuclear Research, Warsaw (Poland)). 1972. 13p. Dep. NTIS (U. S. Sales Only).

In recent experiments, light was scattered from hydrogen plasmas in which the electron component was drifting relative to the ion component. A lack of precise knowledge of the drift velocity corresponding to marginal stability, as well as of what is to be expected when marginal stability is reached, led to a certain amount of vagueness in interpreting these experiments. The present work gives an exact division of parameter space into stable and unstable regions. The dividing line in the space of T_+/T_- versus v_d/v_{the} is seen to have two segments, for which the wave number k that becomes unstable first is nonzero. The values of the critical wave numbers are given. An error often made in calculating the scattered spectrum $S(k,\omega)$ near marginal stability is pointed out. Lastly, some comments on a recent laser scattering experiment (KRONAST and PIETRZYK 1971), are offered. (auth)

39943 STEADY DISCHARGE INTO VACUUM OF A TWO-TEMPERATURE COMPLETELY IONIZED PLASMA. Litvinov, I. I. Zh. Prikl. Mekh. Tekh. Fiz.; No. 6, 10-20(Nov-Dec 1971). (In Russian).

Allowing for the thermal conductivity of electrons and the heat exchange between components, the macroscopic process of plasma discharge from an expansible nozzle is determined by a dimensionless parameter, adiabaticity. The distribution of gasdynamic and electric parameters of the plasma flow and the relation between generalized exit parameters were found. The energy of ions at infinity (due to the high thermal conductivity of the electrons) may be considerably higher than the energy at adiabatic flow. For attainment of the latter, an impractically large nozzle expansion would be essential. (tr-auth)

39944 VELOCITY DISTRIBUTION, PARTICLE DENSITY, TRANSVERSE DRIFT VELOCITY, AND ENERGY DENSITY OF NEUTRAL GASES IN FREE-FALL COLUMNS UNDER CONDITIONS OF NEUTRAL GAS CONSUMPTION DURING IONIZATION PROCESSES. Valentini, H.-B. (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Beitr. Plasmaphys.; 11: No. 6, 483-99 (1971). (In German).

A neutral gas rarefaction caused by ionization processes occurs in plasma of low-pressure gas discharges. The velocity distributions, the particle density, the transverse drift velocity, and the energy density of the neutral gas are calculated both for the plane and for the cylindrical positive column under free-fall conditions. The neutral-gas rarefaction is taken into account. It is shown that the velocity distribution is nonMaxwellian and anisotropic. The pressure tensor is anisotropic, too. Particle density and energy density of the neutral gas decrease with increasing electron density, and the electron temperature is relatively homogeneously over the cross section of the column; only, if the degree of ionization is high, these densities are much smaller near the axis than at the wall. Decreasing neutral-gas temperature causes a similar change in the particle-density profile as increasing electron density and electron temperature do. The transverse neutral-gas pressure decreases from the axis to the wall in all cases. In the steady-state column, an upper limit exists for the transverse particle current density of the neutral gas and of the ion gas. This limit depends on the gas temperature, the filling pressure, and the atomic mass of the filling gas. The Boltzmann equation is given in a form suitable to investigate cylindrical problems. (auth)

39945 CHARGED-PARTICLE DENSITY, NEUTRAL-GAS DENSITY, ELECTRIC POTENTIAL, AND ELECTRON TEMPERATURE IN CYLINDRICAL DIFFUSION COLUMNS TAKING INTO ACCOUNT ELECTRON PRESSURE. Valentini, H.-B. (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Beitr. Plasmaphys.; 11: No. 6, 501-10(1971). (In German).

The profiles of charged-particle density, neutral-gas density, charged-particle generation, and the electron temperature itself are calculated in the cylindrical positive column under diffusion conditions. The electron pressure is taken into account. The nonlinear differential equations for the charged-particle and neutral-gas densities are solved by means of relatively well-converging power series. Inside the column, the neutral-gas partial pressure decreases with increasing electron partial pressure. Thereby, the profiles for charged-particle density and electrical potential are flattened near the axis and fall more rapidly near the wall, and the electron temperature increases. The electron pressure increases with rising electric power input into the column. The necessary condition for the existence of a steady-state low-pressure discharge with high densities is investigated briefly. (auth)

39946 MASS AND HEAT TRANSFER IN A DIATOMIC GAS. Haas, J. C.; Arpaci, V. S.; Springer, G. S. (Univ. of Michigan, Ann Arbor). J. Plasma Phys.; 6: No. 3, 547-60(Dec 1971).

The transfer of mass and heat through a diatomic gas bounded by two plane parallel surfaces is investigated by a kinetic model which includes translational, rotational and vibrational degrees of freedom. A full range moment method is employed in the solution. Numerical solutions obtained for small temperature and pressure differences show the effect of inelastic collisions on the mass and heat fluxes. Approximate analytical expressions are derived for the mass and heat transfer rates, which are valid over the entire density range and yield the correct free-molecule and continuum limits. The results agree well with existing heat transfer and density measurements. (auth)

39947 QUASI-LINEAR RELAXATION OF FAST IONS MOVING TRANSVERSE TO A MAGNETIC FIELD. Kulygin, V. M.; Mikhailovskii, A. B.; Tsapelkin, E. S. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: No. 12, 1111-16(Dec 1971).

The quasi-linear relaxation of a group of fast ions in cold plasma moving transversely to a magnetic field is theoretically investigated. This problem is relevant to experiments on the trapping of fast ions created by the ionization of neutrals injected into magnetic containment systems. The system of quasi-linear equations describing the relaxation is solved by means of a computer. It enables the relaxation of a multi-dimensional velocity particle distribution and multi-dimensional wave spectrum to be analyzed. The results obtained illustrate some general theorems of quasi-linear theory of multi-dimensional systems. The results are compared with those obtained for a one-dimensional system. (auth)

39948 THIN ELECTROSTATICALLY SELF-FOCUSING ELECTRON STREAMS. McCorkle, Richard A.; Bennett, Willard H. (North Carolina State Univ., Raleigh). Plasma Phys.; 13: No. 12, 1153-61(Dec 1971).

A study was made of 30 to 380 microampere, 50 to 550 V, 1 to 2 mm electrostatically self-focusing electron streams 50 cm long drifting through mercury vapor at 5×10^{-5} to 2×10^{-3} torr in a tube of radius 6.6 cm, the inside surface of which tube is coated with a transparent coating whose resistivity is 50 ohm-centimeters per centimeter. In order to determine, without disturbing the system, the potential profile in and around the beam as well as the charged particle densities present, a multigrid electrostatic charged particle energy analyzer was used to study separately the energy distributions of both electrons and ions ejected from the beam radially and approaching the wall. The results show two energy groupings for electrons: a "high" energy group whose energy distribution is that produced by ionizing collisions between beam electrons and neutral gas atoms, and a low energy group that become trapped in the potential well in and around the beam and subsequently escape by collisional mechanisms. For ambient gas pressure below 3×10^{-4} torr, the energy distribution of the ions as they arrive at the wall shows that most of the ions move in free flight to the wall but a few suffer charge exchange with the gas. For pressures above 3×10^{-4} torr, a significant fraction of the ions suffer charge exchange. (auth)

39949 CASCADE EXCITATION OF HYDROGEN ATOMS ON PASSING THROUGH DENSE PLASMA AND GASEOUS TARGETS. Grechukin, D. P.; Karpushkina, E. I. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 14: No. 1, 53-90(Jan 1972).

An analysis is given of the cascade excitation of hydrogen atoms, passing with a velocity $v = 2 \times 10^8$ cm/sec through dense plasma (10^{12} to 10^{14} cm^{-3}) and gas (10^{15} to 10^{16} cm^{-3}) targets, of various degrees of ionization α, situated outside a trap. An investigation is made of the efficiency of the cascade process in which there is an increase in the population of the upper levels of the hydrogen atom with principal quantum numbers n = 10, 11, 12. Lorentz ionization subsequently occurs in the magnetic trap for these levels. The aims of the present work are limited to the calculation of the transformation function $\Phi_{nk}(t)$ for a beam of hydrogen atoms. (UK)

39950 rf TRANSMISSION BETWEEN TWO WHIP ANTENNAE IN A WARM PLASMA. Renard, C. (Faculte des Sciences, Orleans, France). Plasma Phys.; 14: No. 1, 91-2(Jan 1972).

The electric field in the vicinity of a whip antenna at a constant-amplitude alternating potential was measured for various frequencies by means of a similar whip directly connected at its base to a high-input-impedance preamplifier. The high-level signal received as a consequence of a dipolar resonance of the sheath surrounding the receiving antenna is explained. (UK)

39951 EXACT LINEAR DIELECTRIC OPERATOR FOR STRATIFIED PLASMA STREAMS WITH VELOCITY GRADIENTS. Gratton, J.; Gratton, F. (Univ., Buenos Aires). Plasma Phys.; 14: No. 1, 92-6(Jan 1972).

A method is used to obtain the exact linear dielectric operator for a stratified plasma flowing parallel to an external uniform magnetic field with a general velocity profile, and some approximations are discussed. The results are relevant to diagnostics with electromagnetic waves and for analysis of instabilities of the Kelvin–Helmholtz type. (UK)

39952 EVIDENCE FOR HIGH TEMPERATURES IN MINUTE PLASMA POINTS FROM X-RAY SPECTRA OF Fe XXV AND Fe XXVI. Schwob, J. L.; Fraenkel, B. S. (Hebrew Univ., Jerusalem). Phys. Lett.; 40A: No. 1, 81-2(19 Jun 1972).

Analysis of profiles and intensities of lines emitted by Fe XXVI and Fe XXV in a vacuum spark show presence of extremely high temperatures. Electronic temperatures higher than 4 keV and ionic temperatures as high as 30 keV exist in minute plasma points. (auth)

39953 FIZIKA PLAZMY I PROBLEMY UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA. VYPUSK 2. (Plasma Physics and the Problems of Controlled Thermonuclear Synthesis. Number 2). Tolok, V. T. (ed.). Kiev; Naukova Dumka (1971). 308p.

This collection of 26 articles by various authors is divided into three parts: the interaction of plasma bundles with magnetic fields, plasma injectors, and magnetic traps. The first part is concerned with axisymmetric, high-frequency, pulsed-multipole, skew, and divertor magnetic fields. Two papers comprise the second part: plasma bundle forming with the aid of a pulsed magnetic barrier and microwave and x-ray discharges in a coaxial plasma bundle. The last part (15 papers) is concerned with the use of magnetic traps in stellarators, plasma injection, critical angles, wide-aperture targets, and related topics. (K.S.W.)

39954 DETERMINATION OF TRANSPORT PROPERTIES FROM ARC EXPERIMENTS: METHODS AND RESULTS. Bauder, Uwe H.; Maecker, Heinz H. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Proc. IEEE (Inst. Elec. Electron. Eng.); 59: No. 4, 588-92(Apr 1971).

The electrical and thermal conductivities at atmospheric pressure of nitrogen and hydrogen as determined from arc experiments are reviewed for temperatures up to 26,000°K. First results of a high-pressure argon program applying similar experimental and analytical techniques are included. (auth)

39955 INFLUENCE OF DIFFUSION AND NONEQUILIBRIUM POPULATIONS ON NOBLE-GAS PLASMAS IN ELECTRIC ARCS. Uhlenbusch, Juergen F.; Fischer, Ernst (Technical Univ., Aachen). Proc. IEEE (Inst. Elec. Electron. Eng.); 59: No. 4, 578-87(Apr 1971).

Measurements and calculations of temperatures, densities, and field-strength-current characteristics of cascade arcs burning in noble gases under atmospheric pressure are reported. The evaluation of measured arc data assuming Saha equilibrium [complete local thermal equilibrium (LTE)] is not in agreement with the detailed solution of the balance equations. The temperatures of electrons and heavy particles and the density of electrons and neutrals have to be determined from the set of rate equations, from the equation of state, connection with the electron energy balance and the equation of state, the energy balance of the electron gas, and of the total plasma. Solutions of these equations are compared with results following from measured line intensities only solving the rate equations in connection with the electron energy balance and the equation of state. For helium, both methods give results that agree within a few percent. The deviations from Saha equilibrium are caused by diffusion and the overpopulation of ground state atoms. The excited atoms, however, are nearly in equilibrium with free electrons in the range of electron densities reached in our experiment (partial LTE). Measurements of E—I characteristics agree with calculated data, if diffusion is taken into account. A simple criterion for the limit between diffusion-dominated plasma and a plasma in thermal equilibrium is derived. (auth)

39956 HIGH-TEMPERATURE AERODYNAMICS WITH ELECTROMAGNETIC RADIATION. Anderson, John D. Jr.; Winkler, Eva M. (Naval Ordnance Lab., White Oak, Md.). Proc. IEEE (Inst. Elec. Electron. Eng.); 59: No. 4, 651-8(Apr 1971).

In recent years, the basic study and concepts of the interaction between radiation and matter have found application in aerodynamic problems of engineering interest. This paper discusses three such problems actively being examined at the Naval Ordnance Laboratory (NOL): (1) thermally radiating high-temperature shock layers, (2) electric arc-driven wind tunnels, and (3) gas-dynamic lasers. Special emphasis is given to the area of gas-dynamic lasers. New research results recently obtained at NOL are presented and discussed. (auth)

39957 KINETIC REFLECTION CONSTANT. Cherkovets, V. E. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 2046-8(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2577-80(Dec 1971).

The electron-energy distribution and electron current at the boundary between a plasma and a nonemitting electrode are determined, taking account of the angular distribution. The kinetic reflection constant is calculated. (auth)

39958 THEORY OF THE POSITIVE COLUMN. Potapov, A. V.; Proshkin, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 2026-31(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2552-8(Dec 1971).

A longitudinal cylindrical discharge with ambipolar conditions is analyzed numerically on the basis of the 13-moment approximation. The following factors are taken into account: the change in electron temperature and the temperature of the heavy particles over the radius of the tube, the dependence of the transport properties on the temperature and composition of the plasma, the effect on the heat and diffusion fluxes of barodiffusion and heat diffusion, stepwise ionization in the volume of the plasma and positive surface ionization on the walls, thermionic emission from the walls, and the potential drop near the walls. It is shown that surface and volume effects, previously neglected in a positive column, can play an important role under certain conditions. Examples of discharges with a relative minimum of electron density on the axis of the discharge, with a relative minimum of electron temperature, and with an electron density near the walls of the same order as the density inside the discharge are presented. (auth)

39959 IONIZATION AND OPTICAL ABSORPTION BEHIND A STRONG SHOCK WAVE IN HYDROGEN. Anisimov, S. I.; Fisher, V. I. (Inst. of Theoretical Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 2041-5(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2571-6(Dec 1971).

The influence of the deviations from ionization equilibrium on the width and structure of the optical absorption zone behind a strong shock wave in hydrogen is considered. With equilibrium gas temperatures behind the shock that are less than the ionization potential by a factor of two or three, the zone width is governed by ionization. At temperatures close to or above the ionization potential, the electron density in the optical-absorption zone can be regarded as being in local equilibrium. The structure of optically absorbing shock waves is examined and the flow parameters behind the wave are calculated as functions of the radiation flux density and the density of the unperturbed gas. (auth)

39960 ELECTRICAL BREAKDOWN OF THE SPACE BETWEEN A PLASMA AND A POSITIVE ELECTRODE. Kreindel, Yu. E.; Nikitinskii, V. A. (Tomsk Inst. of Radio Electronics and Electronic Engineering, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1888-91(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2378-82(Nov 1971).

The flow of current in a low-pressure gap between a plasma and a positive electrode is analyzed. The condition for gap breakdown is derived and the prebreakdown values of the current for given gap width are presented. The results are compared with earlier experimental data. (auth)

Kinetics (Experimental)

39961 (UCRL—51175) EXPERIMENTAL DETERMINATION OF THE DECELERATION OF FAST IONS IN A DENSE PLASMA: THE COEFFICIENT OF DYNAMICAL FRICTION. Burke, Robert Justin (California Univ., Livermore. Lawrence Livermore Lab.). Feb 1972. Contract W-7405-eng-48. 90p. Dep. NTIS.

An experiment to measure the energy loss rate of fast ions in a plasma is described. In the experiment, proton and deuteron test particles lose energy predominantly to plasma electrons of comparable thermal speed. Interaction of the test particles with the plasma is limited to the path between two charge changing reactions. The time of interaction is measured via the cyclotron frequency of the test ions and the angle between the paths by which the test particles enter and leave the plasma. The observed energy losses are compared to the predictions of the well-known Spitzer formula and to recent calculations which include corrections arising from rigorous treatment of close collisions and cooperative effects. After an extensive analysis of possible errors, it is concluded that the Spitzer formula underestimates the energy loss by about a factor of two. Disagreement with recent calculations amounts to about a factor of three. Previous experiments are discussed and their results are reported. Possible errors which could move the differing results toward agreement are suggested. It is proposed that the discrepancy may emanate from containment of the plasma via the concomitant nonthermal equilibrium. (auth)

39962 INVESTIGATION OF THE EXISTENCE RANGE OF A BOLTZMANN DISTRIBUTION IN AN ARGON ARC PLASMA. Neumann, W. Beitr. Plasmaphys.; 11: No. 3, 249-72(1971). (In German).

Using as plasma source a wall-stabilized argon arc working within a restricted parameter range (inner tube diameter = 7 mm, pressure = 30 to 120 torr, current = 5 to 20 A) the existence of a Boltzmann equilibrium between spectral energy levels is checked by comparing measured occupation number densities of higher excited levels ($N_{m,exp}$) with the corresponding number densities calculated under the assumption of Boltzmann equilibrium ($N_{m,calc}$). The methods for determination of the quantities $N_{m,exp}$, T_g(2300 to 5405°K), T_e(7170 to 9950°K) and N_e (0.33 to 2.4×10^{15} cm^{-3}) needed for this comparison are described. It can be shown within the limit of experimental error that a Boltzmann equilibrium exists at least for electron densities of $N_e > 3 \times 10^{14}$ cm^{-3}. The problem of energy balance of that type of arcs used in these experiments is discussed. (38 references) (auth)

39963 EXPERIMENTAL INVESTIGATION OF TRANSPORT PROPERTIES OF LOW-TEMPERATURE PLASMA BY MEANS OF ELECTRIC ARC. Asinovskii, E. I.; Kirillin, A. V.; Pakhomov, E. P.; Shabashov, V. I. (Inst. of High Temperatures, Moscow). Proc. IEEE (Inst. Elec. Electron. Eng.); 59: No. 4, 592-601(Apr 1971).

Results of experimental investigations into the transport properties of low-temperature plasma carried out since 1960 in the Institute for High Temperatures of the USSR Academy of Sciences are summarized. Serving as the source of plasma was a wall-stabilized dc arc. Properties of argon, nitrogen, air, and carbon dioxide plasma were studied at atmospheric pressure and at temperatures ranging from 7,000 to 16,000°K. Data are presented on electric and thermal conductivity, total radiation of the aforementioned gases, and argon viscosity up to 13,000°K. (auth)

39964 EFFECTS OF FORCED CONVECTION UPON THE CHARACTERISTICS OF A STEADY-STATE CROSS-FLOW ARC IN THE PRESENCE OF AN APPLIED TRANSVERSE MAGNETIC FIELD. Baker, Allen J.; Benenson, David M. (State Univ. of New York, Buffalo). Proc. IEEE (Inst. Elec. Electron. Eng.); 59: No. 4, 450-7(Apr 1971).

Experiments were conducted upon a 130-A 1.1-atm balanced argon arc over a range of velocities from 5.09 to 13.13 m/s; electrode spacing was 12.7 mm. Two stable modes of operation were found: the collinear mode, with arc attachments fix at the apexes of the electrodes, and the upstream mode, with arc attachments on the upstream sides of the electrodes. Below a critical velocity of about 5 m/s, the collinear mode only was found. For the collinear mode, arc isotherm distributions, cross-sectional shape, and profile varied markedly with distance along its length; these were observed to be relatively uniform for the upstream mode. Significant lateral broadening of both configurations was found. The effect of velocity upon the upstream mode was to decrease the relative broadening of the plasma. (auth)

39965 ANISOTROPIC ELECTRIC FIELDS DUE TO ION-ACOUSTIC TURBULENCE IN A rf DISCHARGE. Berezin, A. B.; Dubovoi, L. V.; Lyublin, B. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1844-6(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2323-6(Nov 1971).

The Stark broadening of atomic hydrogen lines in the emission spectrum of a high-current rf discharge is investigated. Anomalous broadening of $H\beta$ and $H\gamma$ in the emission perpendicular to the axis was observed. The peak values of E_Z and E_r due to fluctuations in the plasma are estimated under the assumption that the observed line broadening is caused by the Stark effect in the turbulent fields. In these experiments, $E_Z \approx 2$ kV/cm, $E_r \lesssim (1/3)E_Z$, while the plasma turbulence is characterized by $\beta^{-1} = E_{eff}^2/8\pi mT \approx 10^{-4}$. The effective electron collision frequency $\nu_s \approx \omega_{pe} \quad \beta^{-1} = 2 \times 10^8$ sec^{-1}, calculated from the value of β, is in satisfactory agreement with the value $\nu_s = 2.5 \times 10^8$ sec^{-1} measured earlier from the plasma conductivity. (auth)

39966 MICROWAVE DISCHARGE IN STRONG MAGNETIC FIELDS. Arkhipenko, V. I.; Budnikov, V. N.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1855-7(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2337-40(Nov 1971).

A microwave discharge was investigated in a magnetic field greater than the cyclotron field far from the absorbing limit, i.e., $H > H_c - mc\omega/e$, with $\omega < \omega_{He} = eH/mc$. The conditions are as follows: argon plasma at 10^{-1}-10^{-3} mm Hg in a quartz tube 70 cm long and 2.5 cm in diameter inside a 10-cm waveguide. In the absorption region, certain lines are observed at which there occur discontinuous changes in the parameters of the discharge. The locations of these lines are described by the formulas for one-dimensional wave conversion similar to those for the conversion limits. (auth)

39967 LOW-DENSITY ROTATING PLASMA IN A MIRROR. Konstantinov, S. G.; Myskin, O. K.; Sorokin, A. F.; Tsel'nik, F. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 2006-10(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2527-33(Dec 1971).

In a Penning discharge in a magnetic mirror it is found that plasma oscillations can be suppressed under certain conditions. The plasma lifetime is a few milliseconds in the stable-confinement mode and is roughly equal to the characteristic time for charge exchange on the residual gas. The energy spectra of the neutral atoms formed in charge exchange and the radial distribution of the electric potential in the central plane of the trap were measured. As the electron flux from the ends increases, the plasma-rotation rate and ion temperature increase. The plasma becomes unstable if the ion Larmor radius is sufficiently large. (auth)

39968 ELECTROMAGNETIC RADIATION FROM A BEAM–PLASMA SYSTEM IN A STRONG MAGNETIC FIELD. Aleksandrov, V. O.; Levitskii, A. N. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1847-51 (May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2327-33(Nov 1971).

The results of an experimental investigation of the electromagnetic radiation from a beam–plasma system in a magnetic field are presented. The measurements are performed using a video receiver in the 10 to 40 GHz range and a superheterodyne receiver at 12.2 GHz. In a strong magnetic field ($\omega_H^2/\omega^2 \gg 1$, where ω_H is the electron cyclotron frequency and ω is the signal frequency) there is a simple relation between the longitudinal component of the wave vector of the slow electromagnetic wave (k_2) and the radiated power. The radiation power level can be increased by two or three orders of magnitude by producing a longitudinal magnetic field gradient. This feature has been demonstrated experimentally. (auth)

Kinetics (Theoretical)

Refer also to abstracts 39081 and 40068.

39969 (COO–2059-12) COMPARISON OF VARIOUS NUMERICAL SOLUTIONS TO THE NONLINEAR VLASOV EQUATION. Emery, Mark H. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan 1972. Contract AT(11-1)-2059. 143p. Dep. NTIS.

Thesis.

Several methods for solving the nonlinear Vlasov equation are reviewed and compared. Numerical solutions of the Vlasov and Poisson set of equations for two physically significant problems are presented, and a comparison is made with the results of particle simulations. The problems considered are one-dimensional, with periodic boundary conditions and involve (1) Landau damping in a Maxwellian plasma, and (2) the two-beam instability with equal electron beams. The numerical solutions of the Vlasov equation are based on the Fourier–Hermite and the power transform methods. A review of the Fourier–Hermite method is given, with emphasis on the truncation difficulties. The power transform method is discussed, and several truncation techniques are presented. It is found that an extrapolation procedure can be used that allows a truncation of the infinite matrix without causing numerical instabilities in the nonlinear system. Close quantitative agreement between the results of the two methods is found. The particle simulations are based on the particle-in-cell method. Length weighting and the ''quiet start'' technique are used to suppress the noise and accurately control the initial conditions. A small external electric field is utilized to initially perturb the system. Due to the relatively low noise level, Landau damping can be observed for a period of time. A decrease in the amplitude of the trapping oscillations is observed for the two-beam instability. (auth)

39970 (EUR-CEA-FC–638) RF ELECTRIC FIELD IN AN ELECTRON ION PLASMA CONDENSER WITH AND WITHOUT A MAGNETIC FIELD: EFFECT OF HYBRID FREQUENCIES. Lepechinsky, D. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1972. 14p. (In French). Dep. NTIS (U. S. Sales Only).

One considers a homogeneous plasma slab of constant thickness, between two parallel infinite metal plates with adjacent empty sheaths and an rf voltage applied between the plates. The resulting rf fields inside the plasma and the sheaths are calculated using the ''quasi-static'' approximation ($E_{RF} \cong -\nabla\phi_{RF}$); the resonances and antiresonances of the system are found, with and without a permanent magnetic field $\vec{B}_0$ parallel to the plates, taking into consideration a finite electron temperature and the ion motion. The work evidences the penetration of low-frequency rf fields within the plasma slab and thus the accessibility of the latter to the rf resonances in this device, making possible an rf heating of the ions (e.g., on the ''modified'' lower hybrid frequency) in the presence of an appropriate dissipative mechanism. (auth)

39971 (MATT–777) MULTIPLE IONIZATION IN HIGH-TEMPERATURE PLASMAS. Hinnov, Einar (Princeton Univ., N. J. Plasma Physics Lab.). Sep 1970. Contract AT(30-1)-1238. 40p. Dep. NTIS.

The degree of ionization that an atom reaches in a plasma of specified electron temperature and density in a specified time is estimated from known and extrapolated rates of ionization and recombination. In laboratory plasmas, the time interval in question may be interpreted as the mean ion confinement time, or a time during which the electron temperature remains approximately constant, provided the latter is shorter than the ion confinement time. Data are presented for the time required for various atoms to reach the neon-like, the helium-like, and the fully stripped state. From these, the ionization time for any other state may be found by interpolation. The electron temperatures considered range from 10 to 10^6 eV. The density range is somewhat ambiguous, since it appears only as the product with the time interval available for ionization (from about 10^8 to 10^{15} cm^{-3} sec), but the results should be applicable to most laboratory plasmas. Some possible applications for plasma diagnostics are discussed. (auth)

39972 FORMATION OF A VORTEX OF ELECTRIC CURRENT DURING THERMAL ACCELERATION OF A COMPLETELY IONIZED PLASMA. Shubin, A. P. Zh. Prikl. Mekh. Tekh. Fiz.; No. 6, 30-4(Nov-Dec 1971). (In Russian).

A steady-state two-dimensional slowly changing flow of completely ionized nonviscous quasi-neutral plasma was examined in a contoured duct with continuous metal walls. The Hall effect was taken into account. For values of $\beta \gg 1$, acceleration of the plasma is necessarily accompanied by the appearance of magnetic fields and an electric current, the distribution of which at small discharging potentials has a vortex character. Here $\beta = 8\pi p/B^2$, where p is the gas-kinetic pressure of a plasma and B is the intensity of the magnetic field. The current vortex disappears after an increase in the discharging potential. (tr-auth)

39973 SELF-CONSISTENT KINETIC EQUATIONS AND THE EVOLUTION OF A RELATVISTIC PLASMA IN AN AMBIENT MAGNETIC FIELD. Lee, Martin A. (Univ. of Chicago). Plasma Phys.; 13: No. 12, 1079-98(Dec 1971).

A kinetic theory is developed for a relativistic, spatially-homogeneous multispecies plasma embedded in a uniform ambient magnetic field. The theory treats individual particle effects and collective effects on equal footing, and thereby describes both stable and weakly unstable plasma. The three-particle correlation, and nonlinear mode–mode coupling terms are neglected and a ''quasilongitudinal, weak-field'' approximation is employed in calculating the electric and magnetic field fluctuations. The final equations for the long time evolution of the particle distribution functions and the plasma wave intensities emphasize that the evolution of particles and their "self-excited" waves is coupled in a nonlinear manner. Specialized equations for a plasma consisting of cold electrons and protons and a relativistic proton "tail" are given. These are particularly suited to a discussion of cosmic ray propagation through the interstellar medium no matter whether the cosmic ray distribution is stable or unstable. (auth)

39974 NUMERICAL INVESTIGATION OF THE ANOMALOUS RESISTIVITY DUE TO TWO-STREAM INSTABILITY. Chodura, R. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.); Bardotti, G.; Engelmann, F. Plasma Phys.; 13: No. 12, 1099-1110(Dec 1971).

The appearance of anomalous resistivity and the accompanying heating, due to two-stream instability, is numerically investigated for a plasma whose initial electron and ion temperatures are equal and in which a static electric field is present, using a one-dimensional quasilinear approximation. It is shown that a temporal limitation of the current and strong electron heating can occur in a weakly turbulent regime. In all cases considered, the electron drift velocity u turns out to be larger than the electron thermal velocity v_{eth}, the ratio u/v_{eth} tending to 1. These results are in good agreement with those of both one- and two-dimensional numerical experiments. (auth)

39975 CUT-OFF CRITERIA OF ELECTRONIC PARTITION FUNCTIONS AND TRANSPORT PROPERTIES OF THERMAL PLASMAS. Capitelli, M. (Univ., Bari, Italy). J. Plasma Phys.; 7: No. 1, 99-106(Feb 1972).

It is shown that the effect of the cutoff criteria of the electronic partition functions on transport properties varies with the particular coefficient considered. For example, the cutoff has little effect on translational thermal conductivity, but a large effect on viscosity and reactive thermal conductivity. (auth)

39976 THERMODYNAMICS OF THE RELAXATION OF A TEMPERATURE ANISOTROPY IN A COLLISIONLESS PLASMA. Montes, C.; Peyraud, J. (Observatorie, Nice). J. Plasma Phys.; 7: No. 1, 67-79(Feb 1972).

A new method for dealing with a typical quasi-linear problem is presented. The quasi-linear relaxation of the temperature anisotropy of a collisionless plasma is completely described within the framework of the thermodynamics of irreversible processes. This is obtained by means of generalized Onsager relations applied to the weakly unstable system. Free energy of the system is analyzed in detail, to study the net work involved in the process. (auth)

39977 APPLICATION OF GENERAL KINETIC EQUATION: A GENERALISED VLASOV EQUATION. Demendy, Z. (Univ. of Heavy Industry, Miskolc, Hungary). Physica; 59: No. 1, 14-22(1 May 1972).

A general kinetic equation derived previously will be applied to closed inhomogeneous and to closed homogeneous systems. For the latter case, a concise operator form of the Balescu–Lenard equation (BLE) is given. It is shown that the general kinetic equation contains a new, generalized Vlasov equation (GVE) which shows an explicit nonlinearity of infinite order for the transport coefficients. The first nonlinear correction to the conductivity tensor of an electron plasma is given. (auth)

39978 OBSERVATION ON THE GENERATION OF THE THIRD-HARMONIC CURRENT DENSITY FOR A FULLY IONIZED PLASMA IN A HIGH-FREQUENCY ELECTRIC FIELD. Lupu, Gheorghe (Univ., Cluj). Rev. Roum. Phys.; 17: No. 2, 257-9(1972).

It is found that only the terms in the $\alpha^{1/2}$ approximation are nonzero. The other ones are identically zero ($j_{\pm 1.0} = j_{\pm 3.0} \equiv 0$). (auth)

39979 ESTIMATING COULOMBIAN TRANSPARENCY AS A TEMPERATURE FUNCTION IN AN INFINITE PLASMA WITH POINT-LIKE DEUTERONS. Ionescu-Pallas, Nicholas J.; Mihailescu, Ion N. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 3, 393-7(1972).

In order to perform calculations for the production rates of the fusion reactions in a deuterium plasma, one needs to know the averaged value of $\sigma \nu_r$, where σ is the cross section of an elementary process, while ν_r is the relative velocity, taken over the velocity distribution of the deuterons, in the plasma. As up to temperatures of 10^{10}°K, the respective nuclear processes are still strongly unresonant, the cross section σ may be split into two factors: one of them, of pure nuclear nature, depends on $1/\nu_r$ and the other is related to the probability of the penetration through the Coulombian barrier, by the deuterons $\sigma = \sigma_n D$, $\sigma_n \alpha 1/\nu_r$. One then has to carry out only the averaging of the Coulombian transparency D over the velocity distribution of the ions in the plasma. In the case of an infinite plasma, the velocity distribution is that given by Maxwell. (auth)

39980 ELECTRON–HEAVY PARTICLE COLLISIONAL RELAXATION IN STRONG RADIATION FIELDS. Pert, G. J. (Univ. of Hull, Eng.). Phys. Lett.; 40A: No. 1, 63-4(19 Jun 1972).

The behavior of the electron relaxation time in a strong radiation field is considered for various power-law dependent interactions. It is shown that for Coulomb and dipole interactions, the electron mean free time is significantly increased when the electron oscillation energy in the field becomes comparable with its thermal energy. As a result appreciable change in the transport coefficients may be expected under these conditions. (auth)

39981 NUMERICAL SIMULATION ON PLASMA DIFFUSION IN THREE DIMENSIONS. Okuda, Hideo; Dawson, John M. (Princeton Univ., N. J.). Phys. Rev. Lett.; 28: No. 25, 1625-9(19 Jun 1972).

Three-dimensional plasma numerical simulation on cross-field diffusion was performed for cases with closed and nonclosed field lines of force. For the former case, the diffusion essentially takes the form found for two dimensions showing the three regions of diffusion, while for the latter, the diffusion follows the classical theory to stronger fields. However, the diffusion is always enhanced above the classical level when the magnetic field exceeds a critical value. (auth)

39982 TRANSVERSE DIFFUSION AND CONDUCTIVITY COEFFICIENTS FOR A THREE-DIMENSIONAL MAGNETIZED EQUILIBRIUM PLASMA. Vahala, George (Univ. of Tennessee, Knoxville). Phys. Rev. Lett.; 29: No. 2, 93-5(10 Jul 1972).

Equilibrium transport coefficients are calculated for a three-dimensional magnetized plasma. It is shown that the transverse spatial diffusion and conductivity coefficients are related via a generalized Einstein relation. These coefficients have both a 1/B (volume dependent) term (with B a uniform magnetic field) as well as a $1/B^2$ (volume independent) term for a finite plasma. For an infinite plasma, the coefficients have a "classical" $1/B^2$ dependence. (auth)

39983 INJECTION OF A RELATIVISTIC ELECTRON BEAM INTO A PLASMA. Rosinskii, S. E.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 1989-94(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2504-12(Dec 1971).

The fields and currents induced in a dense plasma by a relativistic electron beam are investigated. For times short compared with the electron–electron collision time in the plasma, the induced fields and currents are given by superposition of the fields and currents which accompany the beam (static in the rest system of the beam) and the transient fields and currents due to injection itself which disappear after the electron–electron collision time. The nature of this transient radiation is evaluated. It is shown, in particular, that the transient fields are essentially electrostatic (magnetic field small compared with the electric field). The problem is solved for two cases: 1) beam injection in a finite time τ, and 2) beam injection in the finite space between the points $z = 0$ and $z = l_0$. (auth)

39984 EFFECT OF INELASTIC COLLISIONS ON THE ELECTRON DISTRIBUTION FUNCTION IN AN ELECTRIC FIELD. Tsendin, L. D. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1804-8(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2271-7(Nov 1971).

It is shown that in the WKB approximation the matching of distribution functions at the boundary of elastic and inelastic regions is governed by a single parameter. An iteration procedure is worked out to find the solution for the case of a nonsmooth energy dependence for the inelastic collision rate. A solution is found for low energies; if the distribution function falls off rapidly at high energies (above the first excitation potential), the low-energy distortion of the distribution function can be extremely large. The energy balance in a plasma is discussed. (auth)

39985 SPHERICAL HARMONICS AND CARTESIAN TENSOR SCALAR PRODUCT EXPANSION IN THE FOKKER–PLANCK EQUATION. Sestak, B. (Technical Univ., Prague). Czech. J. Phys.; 22: No. 5, 341-55(1972).

On the basis of the expansion of the distribution function f(v, r, t) in a sum of spherical harmonics, which is equivalent to a Cartesian tensor–scalar product expansion of the distribution function, i.e., $f(v, r, t) = f_0(v, r, t) + v\ .\ f_1(v, r, t) + vv : f_2(v, r, t) + vvv\ f_3(v, r, t) + \ldots$, where $f_k (k = 2, 3)$ are k-th order irreducible tensors, the Rosenbluth potential functions and the Fokker–Planck collision term are expanded in a similar sum. Collisions terms J_{Fk} $(k = 0, 1, 2)$ and the equations for $f_k (k = 0, 1, 2)$ for the case of the Coulomb interactions are also determined. (auth)

Production

39986 (IPP–1/126) PULSED UV-RADIATION SOURCE FOR PRODUCING HIGHLY IONIZED LOW-DENSITY INITIAL PLAS-

MAS. Gattinger, Anton (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 52p. (In German). Dep. NTIS (U. S. Sales Only).

A 100-kV Z pinch, pulsed-filled with high-density xenon gas, is used as a radiation source for photoionizing hydrogen or rare gases at filling pressures of 1 to 10 mtorr. This produces a homogeneous magnetic-field-free, highly ionized (degree of ionization ≈ 10% in H_2 and ≈ 20% in Ar) plasma suitable, e.g., for collisionless shock-wave experiments. Experimental and theoretical investigations have yielded information on the conversion of the stored electrical energy into radiation energy. As a result of fast magnetic compression and ohmic heating (the relatively low temperature of 6 eV due to multiple ionization of xenon atoms being favorable) the xenon pinch absorbs 30% of the stored electrical energy. Investigation of the matching of the external circuit to the Z pinch by means of the snowplow model shows that the energy transmission efficiency could be increased about 50% if the current half-cycle is made equal to the compression time. The suitability of the xenon pinch as a radiation source is due, on the one hand, to the total emission of the absorbed energy and, in particular, to the spectral distribution of the radiation, which is favorable for the ionization of hydrogen. It is found that the radiation is mainly emitted in lines whose intensity maximum is at the same wavelength, $\lambda \approx 700$ Å, as the maximum of the photoionization cross section owing to the low temperature of the xenon plasma. (auth)

39987 (JUL-820-PP) EXPERIMENTS FOR DETERMINING THE ELECTRON DENSITY IN THE ABSORBING LAYER OF LASER-PRODUCED PLASMAS. Winkelmann, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). Dec 1971. 52p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis.

In a focused beam of a giant ruby pulsed laser, plasmas were produced through heating of thin transparent polypropylene foils. Intensity of the plasma radiation was studied on both sides of the foils within a range from 3600 to 8000 Å. The existence of an optically thick medium was detected through measurement of the intensity ratios as functions of time, wavelength, radiation current of laser light, foil thickness, and angle of observation. The critical electron density, at which frequency of laser light and plasma are equal, could be surpassed; this conclusion was reached through two methods for determination of electron density. (H.B.G.)

39988 (LA-DC-72-415) MOTION OF SOLID D_2 UNDER LASER IRRADIATION. Cooper, Ralph S. (Los Alamos Scientific Lab., N. Mex.). [nd]. 9p. (CONF-720610-1). Dep. NTIS.

From fifth fluid and plasma dynamics conference; Boston, MA. (26 Jun 1972).

A model is derived for the behavior of both the solid and plasma of a deuterium slab under modest intensity ($<10^{14}$ W/cm^2) nanosecond long laser pulses. In the solid, there are two regimes: first, a shock wave propagates through the solid and second, the slab is uniformly accelerated. The transfer of laser energy to kinetic energy in the solid is shown to be $\sim 4\%/\lambda$ (λ = wavelength in microns) during the shock regime and during the acceleration phase is a function only of the fraction vaporized, reaching a maximum of 28%. Model results agree well with detailed numerical simulations. (auth)

39989 (NP-19351) PRODUCTION AND MEASUREMENT OF INTENSE ION BEAMS AND BEAM-PRODUCED PLASMA IN A CUSPED MAGNETIC FIELD. Rijnhuizen Report 72-68. Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Mar 1972. 86p. Dep. NTIS (U. S. Sales Only).

Experimental work is described on the production and current measurement of intense hydrogen-ion beams in pulsed conditions (60 mA at 20 kV). In order to produce an intense ion beam, use is made of a duoplasmatron provided with a plasma-expansion cup at anode potential. Results obtained with various configurations of grids mounted in the ion-extraction region were compared. The use of concave grids appears to be a good expedient for the production of ion beams with sufficient initial focusing to balance space-charge repulsion. Beam-current measurements were made with a Faraday collector provided with a secondary-electron suppressor. Observations show that the voltage needed to suppress the escape of secondary electrons from the collector is approximately proportional to the space-charge potential of the beam in the center of the collector entrance. Special attention was paid to the beam composition as was proved necessary in these experiments. Plasma formation was studied by injection of a 20-keV hydrogen-ion beam into a quadrupole magnetic-containment device. Electron-density measurements were made with a 9-mm microwave interferometer and with resonance-shift methods using the metallic vessel as a cavity. Also, current measurements were made with collectors located in the mirror regions. The plasma density in the steady state appears to be proportional to the gas pressure in the range up to 10^{-4} torr. Under normal conditions (injected current 50 mA, gas pressure 2×10^{-5} torr), the average density is about 5×10^{8} el/cm^3. The observed ion temperature is about 150 eV at low gas pressure whereas the electron temperature does not exceed a few eV. The energy transfer from the hot-ion component to the plasma is in the order of one part per thousand. The energy transfer is thought to be caused by collective effects (beam–plasma interaction). Considerations on the plasma–particle balance lead to the existence of a positive plasma potential in the center during the steady state (about 70 V at low gas pressure). The existence of this potential was confirmed experimentally. (auth)

39990 PHOTOIONIZATION OF A GAS BY THE EXTREME-ULTRAVIOLET RADIATION OF A LASER-CREATED PLASMA. Bruneteau, J.; Fabre, E. (Ecole Polytechnique, Paris). Phys. Lett.; 39A: No. 5, 411-12(5 Jun 1972). (In French).

Photoionization of gases by the far uv radiation of a laser-produced plasma is observed. Maximum electronic number density is estimated to be 10^{13} cm^{-3} at 7 cm from the target. The energy of ionizing photons lies between 85 and 130 eV. (auth)

39991 HOT ELECTRON PRODUCTION IN A BEAM–PLASMA DISCHARGE. Yatsui, K. (Osaka Univ.); Yamamoto, Y.; Saeki, K.; Hasegawa, A. Phys. Lett.; 39A: No. 5, 425-6(5 Jun 1972).

The production mechanism of hot electrons in a beam–plasma discharge was studied. A qualitative agreement between experimental data and theoretical prediction based upon electron cyclotron damping of hf electric field created by two-stream instability is obtained. (auth)

39992 BREAKDOWN OF DEUTERIUM WITH A RUBY LASER. Nielsen, P. E.; Canavan, G. H.; Rockwood, S. D. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Proc. IEEE (Inst. Elec. Electron. Eng.); 59: No. 4, 709-10(Apr 1971).

Solving the quantum-kinetic equation for electrons interacting with deuterium molecules and a 1.8-eV photon field, time-dependent calculations were made of the breakdown of deuterium gas by a ruby laser. One finds that the quantum flux G corresponding to the breakdown threshold E field is given by an equation that is approximately of the form $\ln 44 = \ln [\Delta t/A(G/\omega)] - B(\omega/G)^{1/2}$ where Δt and ω are the laser pulse length and frequency, and A and B are constants. The field-strength thresholds that emerge from these calculations are compared with available experimental data, and good agreement is obtained. (auth)

Stability

Refer also to abstract 39392.

39993 (MATT-770) LOW FREQUENCY COUPLING OF LANGMUIR PROBES TO FLUCTUATIONS IN THE C STELLARATOR. Meservey, E.; Bol, K.; Gorman, J. (Princeton Univ., N. J. Plasma Physics Lab.). Aug 1971. Contract AT(30-1)-1238. 21p. Dep. NTIS.

A brief experiment with the C stellarator is described, on the use of large Langmuir probes as the control elements in a feedback circuit to suppress low frequency plasma fluctuations in standard Ohmic discharges. Such suppression was not achieved, at least in part because the plasma was at all times more turbulent than had been anticipated. It did prove possible to induce fluctuations that under suitable conditions exhibited the properties of drift waves, and with appropriately mode-selective detectors and control electrodes at least a partial suppression of fluctuations ought to be achievable. A more serious problem is the necessity of having the control elements within the plasma aperture since their effect was negligible when they were located in the scrape-off region as originally planned. This limitation would obviously prevent any applications to plasmas of thermonuclear interest. (auth)

39994 STABILITY OF ANISOTROPIC PLASMAS TO ALMOST-PERPENDICULAR MAGNETOSONIC WAVES. Landau, R. W.; Cuperman, S. (Tel-Aviv Univ., Israel). J. Plasma Phys.; 6: No. 3, 495-512(Dec 1971).

The stability of anisotropic plasmas to the magnetosonic (or right-hand compressional Alfvén) wave, near the ion cyclotron frequency, propagating almost perpendicular to the magnetic field, is investigated. For this case, and for wavelengths larger than the ion Larmor radius and for large ion plasma frequency the dispersion relation is obtained in a simple form. It is shown that for $T_{||} \mp T_{\perp}$ (even $T_{||} \gg T_{\perp}$) no instability occurs. The resonant terms are also included, and it is shown that there is no resonant instability, only damping. (auth)

39995 INSTABILITIES OF FORCE-FREE HIGH BETA PLASMA. Mikhailovskii, A. B.; Fridman, A. M. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: No. 12, 1163-73(Dec 1971).

The instabilities are investigated of plasma with large values of the parameter $\beta = 8\pi p/B^2$, where p is the plasma pressure and B is the magnetic field in the plasma. The case is considered of force-free plasma, $\nabla p = 0$, $\nabla B = 0$. In this case some types of instabilities cannot develop due to the absence of macroscopic current and magnetic drift of particles. Analysis shows that even under these conditions some instabilities can develop in plasma as a result of gradients in density n and temperature T. Some instabilities of force-free plasma can be interpreted macroscopically. They can be attributed to the steady thermal flux. This type of instability does not exist in low β plasma. (auth)

39996 WHISTLER INSTABILITY IN PLASMAS WITH ANISOTROPIC AND NON-MAXWELLIAN VELOCITY DISTRIBUTIONS. Lee, Kai Fong (Catholic Univ. of America, Washington, D. C.). J. Plasma Phys.; 6: No. 3, 449-56(Dec 1971).

The instability of right-handed, circularly polarized electromagnetic waves, propagating along an external magnetic field (whistler mode), is studied for electron plasmas with distribution functions peaked at some non-zero value of the transverse velocity. Based on the linearized Vlasov—Maxwell equations, the criteria for instability are given both for non-resonant instabilities arising from distribution functions with no thermal spread parallel to the magnetic field, and for resonant instabilities arising from distribution functions with Maxwellian dependence in the parallel velocities. It is found that, in general, the higher the average perpendicular energy, the more is the plasma susceptible to the Whistler instability. These criteria are then applied to a sharply peaked ring distribution, and to loss-cone distributions of the Dory, Guest & Harris (1965) type. (auth)

39997 RESISTIVE INSTABILITIES. Baldwin, P. (Univ. of Newcastel upon Tyne, Eng.); Roberts, P. H. Phil. Trans. Roy. Soc. London, Ser. A; 272: No. 1223, 303-30(8 Jun 1972).

It has been established by Furth, Killeen & Rosenbluth (1963), and by Johnson, Greene & Coppi (1963), that a hydromagnetic equilibrium which is stable on a theory in which electrical resistance is ignored, may yet be unstable through finite conductivity effects. These authors isolated and categorized several types of such instabilities which, they showed, originate from the critical layer in which the perturbation wavefront is perpendicular to the equilibrium magnetic field. In this paper, the asymptotic properties of the critical layer equations, for large values of the critical layer coordinate, are obtained in a number of cases of interest, using the sheet pinch model with uniform resistivity. The mathematical approach is a novel variant of the Laplace integral representation, which allows results of greater generality to be obtained than those given by previous authors. The technique is applied first to the slow interchange mode, and the restricted (but most significant) class of solutions found by Johnson et al. is recovered. It is also shown that modes entirely localized within the critical layer do not occur. Such modes do exist for the more rapid interchange modes, and a new discussion of these is presented. Finally, the oscillatory resistive modes, which arise when the perturbation wavefront is not perpendicular to the equilibrium magnetic field, are studied by a similar mathematical method, and a class of eigenvalues is obtained. (auth)

39998 RAYLEIGH TAYLOR INSTABILITY OF A VISCOUS HALL PLASMA WITH MAGNETIC FIELD. Bhowmik, G. (Univ. of Delhi). J. Plasma Phys.; 7: No. 1, 117-32(Feb 1972).

The influence of finite Larmor frequency on the stability of a viscous, finitely conducting liquid in a downward gravitational field under the influence of a uniform magnetic field directed along or normal to gravity, is investigated. The solution in each case is shown to be characterized by a variational principle. Based on the variational principle, an approximate solution is obtained for the stability of a layer of fluid of constant kinematic viscosity and an exponential density distribution. (UK)

39999 EFFECTS OF FORCE-FREE FIELDS ON PLASMA STABILITY. Goedbloed, J. P.; Schuurman, W. (EURATOM-FOM, Jutphaas, Netherlands). Plasma Phys.; 14: No. 1, 1-10 (Jan 1972).

It is shown that recent papers by Schuurman et al. (1969) and Freidberg et al. (1970) on the effects of force-free fields on plasma stability suffer from indistinctness regarding assumptions and consequently obscure some of the basic effects associated with these fields. In agreement with the former paper, it is shown that a constant-pitch force-free field stabilizes the kink mode of the plasma column, whereas the latter paper rightly shows that this field introduces a new type of instability by itself. From an expression of the growth rate, however, it is argued that this instability is not as dangerous as the kink mode. Moreover, in disagreement with the conclusions of the latter paper, it is shown that a complete stabilization of all modes is possible by the introduction of more general force-free fields having shear. (auth)

40000 INSTABILITY OF ELECTROMAGNETIC CYCLOTRON HARMONIC WAVES IN PLASMAS. Lee, Kai Fong (Catholic Univ. of America, Washington, D. C.). Phys. Rev., A; 6: No. 1, 355-63(Jul 1972).

The stability of electromagnetic waves propagating perpendicular to a uniform and static magnetic field is studied for plasmas with the ring- and loss-cone-type distributions in the perpendicular velocities. Based on the linearized Vlasov—Maxwell equations and the assumption that the ions are infinitely massive, it is found that instability can occur not only with zero frequency but also near the multiples of the electron cyclotron frequency. In general, the higher the average parallel energy, the more the plasma is susceptible to the instability. If the distribution in the parallel velocities is a stationary Maxwellian, instability occurs only for large ratios of parallel thermal pressure to magnetic pressure ($\beta_{\|t}$). For counterstreaming plasmas with streaming velocities of the order of the electron thermal speed, the instability can occur for $\beta_{\|t}$ values of order unity. A discussion is given on the growth rates of these instabilities. (auth)

40001 TRAPPED-ION INSTABILITY IN THE LOW-ASPECT RATIO LIMIT. Jablon, C. (Paris Univ., Orsay, France). Phys. Lett.; 40A: No. 1, 52-4(19 Jun 1972).

The radially localized trapped-ion mode is studied for small values of the aspect ratio $A = R/a$. A two-step model is used for the magnetic field and the fluctuating potential and a comparison is made with the approximative results obtained for $\nu_{ief} \ll \omega \ll \nu_{eef}$; $\nu_{jef} \cong \nu_j/A$ is the effective collision frequency for trapped particles. For $A \lesssim 20$, the mode becomes curvature-sensitive, while a stabilizing Landau term reduces the growth rate and the unfavorable ion-temperature gradient term. (auth)

40002 NATURE OF THE COLLISION CYCLOTRON INSTABILILTY IN AN IONIZED GAS EXHIBITING THE RAMSAUER EFFECT. Oddou, Christian (Univ., Paris). Compt. Rend., Ser. B; 274: No. 9, 600-3(28 Feb 1972). (In French).

Criteria for determining the nature of an instability are applied to weakly ionized gases exhibiting the Ramsauer effect. Studies of the dispersion equation of the extraordinary plasma mode as a function of the distribution (outside equilibrium) demonstrate that the macroscopic parameters (electron density and collision frequency) affect the stability. The theoretical results obtained agree with the experimental observations made under various conditions. (France)

40003 ELECTROMAGNETIC AND FINITE-β_e EFFECTS ON THE MODIFIED TWO-STREAM INSTABILITY. McBride, J. B.; Ott, E. (Naval Research Lab., Washington, D. C.). Phys. Lett.; 39A: No. 5, 363-4(5 Jun 1972).

Electromagnetic effects are found to stabilize the modified two-stream instability under certain given conditions. The importance of this result to several classes of experiments is discussed. (auth)

40004 RADIAL DISTRIBUTION OF AN INSTABILITY IN AN AFTERGLOW IN A MAGNETIC FIELD. Bulanin, V. V.; Zhilinskii, A. P. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1960-2(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2469-72(Nov 1971).

The radial distribution of the relative magnitude of density fluctuations in an afterglow and the radial profiles of the mean density are determined experimentally. In magnetic fields up to 500 Oe, the mean density distribution is a diffusion distribution. At large magnetic fields, the plasma is concentrated near the axis of the cylindrical chamber. As is shown by the distributions of the relative magnitude of the density perturbations, the instability first grows at the periphery of the plasma column. With the passage of time after the onset of the afterglow, the plasma becomes unstable at smaller radii; at large magnetic fields the oscillations appear over the entire volume of the plasma. (auth)

40005 (IPP-4/96) PRINCIPLES OF CALCULATION, OPTIMIZATION, AND COST FACTORS OF NORMALLY CONDUCTING CRYOTECHNICAL AND SUPERCONDUCTING MAGNETS FOR EXPERIMENTAL PLASMA PHYSICS. Oswald, B. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Nov 1971. 105p. (In German). Dep. NTIS (U. S. Sales Only).

The report includes a number of calculations and optimizing methods for normal conductive, cryogenic, and superconducting magnets in linear (cylindrical) and toroidal devices. As a basis for the comparison of costs of various magnet systems, relevant cost factors and functions are given. (auth)

Thermonuclear Processes

Refer also to abstract 39794.

40006 (UCRL–73187) CRYOGENICS, SUPERCONDUCTING MAGNETS, AND FUSION POWER: A GLIMPSE INTO THE FUTURE. Taylor, C. E. (California Univ., Livermore. Lawrence Livermore Lab.). 29 Oct 1971. 24p. (CONF-710829–1). Dep. NTIS.

From Cryogenic engineering conference; Washington, D. C. (Aug 1971).

The size, shape, and cost of several possible fusion-reactor coil systems are presented, along with refrigeration requirements. There is little question that these large magnet systems are technically feasible to construct. The economic possibility of using nonsuperconducting or partially superconducting ''hybrid'' conductors for large fusion systems is presented, and the possibility that there may not be enough helium available to refrigerate the coils in a hypothetical fusion-power economy eighty years from now is discussed briefly. (auth)

40007 POTENTIAL LARGE-SCALE PLASMA PROCESS: SYNTHESIS OF INEXPENSIVE HYDROGEN BY USING A THERMONUCLEAR DEVICE TO VAPORIZE WASTE ORGANIC MATERIALS. Safrany, David R. (Bechtel Corp. Lab., Belmont, Calif.). Chem. Eng. Progr., Symp. Ser.; 67: No. 112, 103-8(1971).

The use of a nuclear fusion device to vaporize large masses of organic waste materials, with the intent of lowering the cost of synthesizing hydrogen (and, therefore, fixing nitrogen), appears scientifically feasible. Detailed studies of the technological and economic problems, of course, remain to be done. These must include studies of the extent to which communities, perhaps the Federal Government, and even individual corporations are willing to subsidize transportation of waste materials to areas suitable for contained nuclear explosions. The concept appears to provide a novel definitive solution to the current environmental problem of solid wastes disposal. (auth)

40008 CLOSED MAGNETIC FIELDS WITH A SPHERICAL SEPARATRIX . Peregud, B. P.; Semenov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1824-9(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2297-2304(Nov 1971)

The magnetic field due to a surface current I_{in}, distributed in an arbitrary manner over the surface of a sphere of radius R_{in}, and to the image current I_{skin} which arises in a conductor surrounding the surface current is analyzed. The sphere R_{in} and the surface current are located concentrically inside a spherical cavity of radius $R_0 > R_{in}$ formed in a conducting region of finite conductivity. Expressions are found for the field components over the entire space as functions of the time. It is shown that the field which arises in the cavity when the current I_{in} is turned on abruptly can be produced by two geometrically similar currents on two concentric spheres R_{in} and R_{out}, if these currents are in opposite directions and have a ratio $I_{in}/I_{out} = (R_{out}/R_{in})^{1/3}$. This means that the field of such systems has a spherical separatrix of radius $R_0 = (R_{in}/R_{out})^{1/3}$. The fields of two particular systems are analyzed: the field formed by two concentric annular currents and a single linear current passing through the center of the system (a spherator) and the field formed by two linear helical currents on concentric spheres and two semiinfinite linear currents connecting the ends of the helices (the tornado). Equations are given for the field components of these systems. (auth)

40009 FIELD STRUCTURE AND STABILITY IN TORNADO DEVICES. Peregud, B. P.; Petrov, S. Ya.; Chumanov, A. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1838-43(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2316-22(Nov 1971).

An experimental determination was made of the presence, shape, and position of the separatrix as well as measurement of the lifetime of individual particles in a real trap. This study was made possible by the procedure summarized as follows: The system or a model of it (in this case, a two helix Tornado trap with matching turns) is placed inside a 4π collector. A continuously operating electron injector is placed inside the trap. The currents to each of the elements of the system, which are divided into inner and outer elements when a separatrix is present, are measured separately. Outside the trap are the 4π collector and the helical conductors which form the trap; inside the trap are the injector, its holder, and a disc collector inserted into the trap to reduce the electric field set up by the space charge of the electrons which accumulate in the trap. In the absence of electron diffusion and drift, and if the trap is an absolute trap, there must be no current to the outer elements of the system. In a real situation, with small diffusion and drift currents, the dependences of the current to the outer elements of the system on the perturbation level and injector position can yield information about the structure of the trap field. By measuring the space charge accumulated in the trap (in the absence of an inner collector) one can determine the ''partial'' electron lifetime with respect to any of the particle-escape channels, particularly with respect to particle escape from the trap through the gaps in the separatrix. (M.O.W.)

40010 TITANIUM-HYDRIDE INDUCTION INJECTOR. Ivanov, N. V.; Maksimov, G. P.; Markin, A. I.; Smirnov, V. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 2092-3(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2631-3(Dec 1971).

A titanium-hydride injector is described in which a plasma is produced as a result of an induced discharge at the surface of a ceramic disc on which a titanium layer is deposited. The injector can be used to produce a plasmoid 10 cm in diameter with a density of 10^{12} to 10^{14} cm^{-3}, a uniform cross section, and 10^{18} particles. An experimental study of the plasma parameters is reported. (auth)

40011 TOPOLOGICAL STABILITY OF THE MAGNETIC FIELD IN TORNADO-2. Kozyrev, A. N.; Kuznetsov, V. M.; Peregud, B. P.; Fedichkina, Z. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1830-7(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2305-15(Nov 1971).

Calculations are made of the change in the structure of the trap field corresponding to large and small changes in the ratio of helix currents. Particle lifetime calculations are made for an interrupted separatrix. (M.O.W.)

Wave Phenomena

Refer also to abstract 39446.

40012 (MATT–773) CALCULATION OF THE PLASMA DISPERSION FUNCTION. Barberio-Corsetti, P. (Princeton Univ., N. J. Plasma Physics Lab.). Aug 1970. Contract AT(30-1)-1238. 13p. Dep. NTIS.

A simple and efficient code is presented, which computes the plasma dispersion function $Z(\zeta)$. The code can easily be modified to compute Z with a given number of significant figures. The problem of the correct evaluation of ImZ around the real axis is solved. (auth)

40013 STABILITY OF WAVES IN RELATIVISTIC PLASMA. Gupta, R. M.; Varma, N. L. (Univ. of Rajasthan, Jaipur, India). Beitr. Plasmaphys.; 11: No. 3, 195-9(1971).

The dispersion relation of electromagnetic waves propagating perpendicular to an applied uniform magnetic field B_0 in relativistic plasma is derived. Waves propagating perpendicular to the uniform applied magnetic field can be separated into two modes— one is the linearly polarized transverse wave and the other is a hybrid mode. The dispersion relation of the first mode i.e., for a pure transverse wave, is analyzed under the assumption that the wavelength is much longer than the cyclotron radii of the electrons. A stability criterion that limits the thermal energy of the electrons B_0 is obtained. (auth)

40014 ELECTROMAGNETIC WAVE FLUCTUATION IN A PLASMA LAYER. Grechko, L. G.; Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1771-6(Nov 1971). (In Russian).

The spectrum is obtained of slow electromagnetic wave fluctuations in a plasma layer. In the frequency range of $0 < \omega < \omega_p/\sqrt{2}$, there exist fluctuations of symmetric waves; in the range of $0 < \omega < \omega_p$, fluctuations of antisymmetric waves. (auth)

40015 MUTUAL TRANSFORMATION OF MAGNETO-ACOUSTIC WAVES IN PLANE INHOMOGENEOUS SYSTEMS. Deutsch, R. V.; Zoler, D. Beitr. Plasmaphys.; 11: No. 6, 431-44(1971).

An approach is presented for the generation of slow magneto-acoustic waves by fast ones, and vice versa, and to the reflection of magneto-acoustic waves at plasma and magnetic field inhomogeneities. The cases of very strong and very weak fields as well as the case when the Alfvén velocity is of the order of the sound velocity are closely investigated. General conclusions are drawn on the mutual transformation of magneto-acoustic waves. (auth)

40016 GROWTH RATES OF UNSTABLE ION SOUND WAVES IN A CONSTANT ELECTRIC FIELD. Gratzl, Herbert (Univ., Innsbruck). Beitr. Plasmaphys.; 11: No. 6, 523-6(1971).

A constant electric field changes the linear growth rates of ion sound waves. The corrections are small if the field energy is lower than the electron thermal energy times the ratio of electron to ion mass. They depend also on the nonlinear variation of the particle distributions. (auth)

40017 FOKKER–PLANCK TREATMENT OF NON-LINEARLY INTERACTING WAVES. Cook, I (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Plasma Phys.; 6: No. 3, 457-65(Dec 1971).

The statistical properties of nonlinearly interacting waves are considered from a physically motivated viewpoint. A Fokker–Planck wave transport equation is derived. In certain circumstances an H theorem can be proved. (auth)

40018 EXISTENCE CONDITIONS FOR COLLISIONLESS HYDROMAGNETIC SHOCK WAVES ALONG THE MAGNETIC FIELD. Kato, Yusuke (Nagoya Univ., Japan); Tajiri, Masayoshi; Taniuti, Tosiya. J. Plasma Phys.; 6: No. 3, 467-93(Dec 1971).

Existence conditions for steady hydromagnetic shock waves propagating in a collisionless plasma along an applied magnetic field are considered. The electrostatic waves are excluded. The conditions are based on the requirement that solutions of the Vlasov–Maxwell equations deviate from a uniform state ahead of a wave. They are given as the conditions on the upstream flow velocity in the wave frame (i.e. in the form of inequalities among the upstream flow velocity and some critical velocities). The conditions crucially depend on the pressure anisotropy, and demonstrate possibilities of exacting collisionless shock waves for high β plasmas. (auth)

40019 QUASI-WAVE TRAINS IN A COLD COLLISIONLESS PLASMA. Inoue, Yoshinori (Osaka Univ., Toyonaka, Japan). J. Plasma Phys.; 6: No. 3, 513-26(Dec 1971).

Nonlinear hydromagnetic waves in a cold collisionless plasma are investigated by numerical and analytic methods. It is seen from the computer calculations that in general the waves do not have periodicity. Furthermore, some concrete examples show the behavior of these ergodic waves more clearly. The width of the waves is of the order of ion Larmor radius. These waves are here called quasi-wave trains. In some special cases, the waves reduce to wave trains (with periodicity). Some of them have a length scale of the geometric mean between the Larmor radii of the electron and of the ion. (auth)

40020 COLLISIONAL DRIFT WAVES IN THE PRESENCE OF COHERENT ION ACOUSTIC OR LANGMUIR WAVES. Dobrowolny, M.; Negrini, P. (CNEN, Frascati, Italy). J. Plasma Phys.; 6: No. 3, 527-40(Dec 1971).

The dispersion properties of drift waves in a low-β weakly collisional plasma, in the presence of ion acoustic or Langmuir waves parallel to magnetic lines, are investigated. It is shown that the nonlinear interaction with an ion acoustic wave mainly leads to a shift of the drift wave spectrum towards lower frequencies (and only under very particular conditions affects the stability of the drift wave). The interaction with a Langmuir wave, on the contrary, yields a contribution to the imaginary part of the frequency. The conditions under which this stabilizes unstable drift modes are derived and discussed. (auth)

40021 LONGITUDINAL WAVES IN A PERPENDICULAR COLLISIONLESS PLASMA SHOCK. PART 3. $T_e \sim T_i$. Gary, S. Peter (Coll. of William and Mary, Williamsburg, Va.). J. Plasma Phys.; 6: No. 3, 561-6(Dec 1971).

Electrostatic waves in a Vlasov plasma of unmagnetized ions and magnetized electrons undergoing an $E \times B$ drift are considered. The linear dispersion relation is solved numerically for $T_e \sim T_i$. For a fixed ratio of drift velocity to electron thermal velocity, the growth rates of the $E \times B$ electron drift instability are smaller, and the waves are stabilized at much smaller values of $k \cdot B$ than in the $T_e \gg T_i$ case. (auth)

40022 MAGNETO-ACOUSTIC RESONANCE IN A NON-UNIFORM CURRENT CARRYING PLASMA COLUMN. Vaclavik, J. (Univ., Fribourg, Switzerland). J. Plasma Phys.; 6: No. 3, 607-14(Dec 1971).

The forced radial magneto-acoustic oscillations in a plasma column with nonuniform mass density and temperature are investigated. The oscillations have a resonant character similar to that of the magneto-acoustic oscillations in a uniform plasma column. The properties of the axial and azimuthal components of the oscillating magnetic field are discussed in detail. (auth)

40023 GENERALIZED THEORY OF THE STABILITY OF SHOCK WAVES IN MAGNETOGASDYNAMICS. Woods, L. C. (Oxford Univ.). J. Plasma Phys.; 6: No. 3, 615-27(Dec 1971).

Stability of MGD shock waves can be investigated either by disturbing the shock discontinuity by incident waves and then considering whether the response of the shock is unique and determinate or not, or by studying the behavior of the dissipative shock structure with variations in the magnitudes of the dissipations. Both approaches yield the same results, which appears at first sight to be a coincidence. It is shown, from a single treatment that includes each as special cases, why the two methods yield the same conclusions. Also, by including the Hall term on Ohm's law, the uncertainty about the stability of switch-on and switch-off shocks that occurs in the usual MHD treatment of the problem is able to be resolved. Finally, it is shown that the Hall term also introduces the possibility of electric field layers in the unsteady shock and thereby reduces the number of shock boundary conditions. This throws some doubt on the value of the wave-interaction theory for shocks in real plasmas. (auth)

40024 KINETIC THEORY OF THREE-WAVE INTERACTION IN A MAGNETIZED PLASMA. Stenflo, L. (Univ. of Umea, Sweden). J. Plasma Phys.; 7: No. 1, 107-16(Feb 1972).

The resonant interaction between three waves, propagating perpendicular to a constant magnetic field in a spatially uniform plasma, is considered. Significant terms, which have been neglected in the coupling coefficients of previous work, are included. (auth)

40025 SOME ALGEBRAIC SOLUTIONS OF THE CYCLOTRON-RESONANCE INTERACTION. Ho, H. S.; Liemohn, H. B. (Boeing Scientific Research Labs., Seattle). Plasma Phys.; 14: No. 1, 11-26(Jan 1972).

The cyclotron–resonance interaction between electromagnetic waves and nonthermal plasmas is investigated for Cauchy (resonance) velocity distributions which yield algebraic dispersion equations. Combinations of anisotropic and streaming distributions are considered for ions and electrons to ascertain the relative importance of the interaction at different frequencies. Distribution forms and parameter ranges were chosen which would simulate possible conditions in the magnetosphere and solar wind. Because the equations are algebraic, the valid characteristic roots are readily identified, and their unstable nature is determined by conventional convective/nonconvective criteria. (UK)

40026 NON-LINEAR ELECTROSTATIC PLASMA WAVES. Schamel, Hans (Max-Planck-Institut fuer Physik und Astrophysik, Munich). J. Plasma Phys.; 7: No. 1, 1-12(Feb 1972).

A solution of the one-dimensional time-independent Vlasov–Poisson system, including the condition of no net current, is constructed for a large class of electric potential functions, including periodic and solitary waves, as well as monotonic transitions. Displaced Maxwell distributions for the free particles, and an unshifted Maxwell distribution for the trapped ions, are used. The condition of positiveness of the unknown distribution function for the trapped electrons (which can be split into two parts, one depending solely on the chosen wave, the other on the given distributions) is examined. (auth)

40027 SOME STRONG EFFECTS DUE TO WEAK COUPLING IN AN ASSEMBLY OF OSCILLATORS. Peyraud, J.; Peyraud, N. (Observatoire, Nice). J. Plasma Phys.; 7: No. 1, 81-6 (Feb 1972).

The mathematical treatment of the influence of a weak coupling on an assembly of damped oscillators with different eigenfrequencies permits one to exhibit a peculiar property of the solution: namely, the existence of a high-frequency solitary, weakly damped mode. These results are applied to the ionic oscillations of a bounded plasma. (auth)

40028 INTERPRETATION OF DISPERSION RELATIONS FOR BOUNDED SYSTEMS. Rognlien, T. D.; Self, S. A. (Stanford Univ., Calif.). J. Plasma Phys.; 7: No. 1, 13-48 (Feb 1972).

A treatment is given of the problem of constructing normal modes for an arbitrarily bounded system from roots of the linear dispersion relation $D(\omega,k) = 0$ for the corresponding infinite or periodically bounded system. For a system described by continuous macroscopic variables, and of general cylindrical form (uniform along an axis z, say), each transverse eigenmode gives rise to a set of axial normal modes constructed from a pair of dominant roots $k_z^{\pm}(\omega)$ of $D = 0$ satisfying the boundary conditions which are characterized by complex reflexion coefficients for the dominant waves. The implications of the results for the interpretation of experiments on plasma waves and instabilities on finite cylinders are discussed, with particular reference to the effects of end-plate damping and axial current on Q machines. (auth)

40029 MAGNETIC STRUCTURE OF IONIZING SHOCK WAVES. PART 3. NORMAL SHOCKS. Leonard, B. P. (City Univ., New York). J. Plasma Phys.; 7: No. 1, 177-85 (Feb 1972).

Normal ionizing shock waves are considered as a subclass of oblique shocks in which the upstream transverse magnetic field component is zero; i.e. the upstream field is normal to the plane of the shock. Nontrivial (switch-on) normal shocks involve a nonzero downstream transverse field component; magnetically trivial normal shocks are simply gas shocks with an imbedded constant normal magnetic field. As with oblique shocks, switch-on normal ionizing shock waves are plane-polarized, provided the conductivity is a scalar. Ohmic structures are discussed for several values of shock Alfvén number, treating the electric field as a free parameter, as usual. (UK)

40030 MAGNETIC STRUCTURE OF IONIZING SHOCK WAVES. PART 2. OBLIQUE SHOCKS. Leonard, B. P. (City Univ., New York). J. Plasma Phys.; 7: No. 1, 157-76(Feb 1972).

Oblique ionizing shock waves are considered as a subclass of the skew shocks discussed in part 1. It is shown explicitly that, for these cases, when the electrical conductivity is a scalar, the magnetic field and velocity vectors lie in a single plane throughout the shock structure. Details of the shock structure are given in the zero-magnetic-Prandtl-number limit for a range of values of the upstream magnetic pressure ratio as the transverse electric field is varied parametrically. Shocks possessing a magnetic structure are necessarily sub-Alfvénic downstream. Thus some structures are trans-Alfvénic (i.e. super-Alfvénic upstream), and others are completely sub-Alfvénic. Unlike the pre-ionized case, the former are stable to rotational Alfvén disturbances because of their ability to form skew shocks. (auth)

40031 MAGNETIC STRUCTURE OF IONIZING SHOCK WAVES. PART 1. SKEW SHOCKS. Leonard, B. P. (City Univ., New York). J. Plasma Phys.; 7: No. 1, 133-55(Feb 1972).

Initially nonconducting gas is ionized by a thin viscous shock wave. Upstream there can be no magnetohydrodynamic interaction because of the zero conductivity, but the conducting downstream region may have a magnetic structure that interacts with the flow variables. A theoretical analysis is made in the zero-magnetic-Prandtl-number ("non-viscous") limit, i.e., ohmic dissipation is the dominant diffusion mechanism. Unlike magnetohydrodynamic shocks in a pre-ionized gas, ionizing shock waves are not necessarily plane-polarized. Thus "skew" shock structures can exist, in which the upstream and downstream magnetic field vectors and the shock wave normal do not all lie in a single plane. Explicit solutions are given for typical values of the governing parameters. (UK)

40032 NON-LINEAR WAVES IN A NON-UNIFORM PLASMA. Gribben, R. J. (Univ. of Strathclyde, Glasgow). J. Plasma Phys.; 7: No. 1, 49-65(Feb 1972).

A general formulation of the problem of nonlinear waves in nonuniform plasmas is attempted, with attention focused in the main on the Vlasov equation. By the introduction of specific variables to describe the large-scale behavior of the unknowns, a necessary condition is deduced for its solution to contain no secular terms. The form of the result is interpretable as a formal phase average of the original Vlasov equation, with length and time scales corresponding to the slow variation. The associated general form of the boundary conditions is also derived. (UK)

40033 CRITIQUE OF ELECTROMAGNETIC TURBULENT-PLASMA SCATTERING THEORIES. Bugnolo, D. S. Phys. Rev., A; 6: No. 1, 477-84(Jul 1972).

The scattering of electromagnetic waves by a large-scale turbulent plasma has recently become of interest again in connection with the formation and study of the nonequilibrium plasma (often turbulent) of controlled-fusion machines. Other than the usual Born approximation, it has also become fashionable to use the equivalent of the Dyson and Bethe–Salpeter equations, as well as a transport formulation for the scattering wave. The use of these methods has recently been justified by Frisch. These results are considered in a critical fashion. It has been possible to conclude that the results obtained from a solution of the stochastic transport theory are valid in both the high- and low-frequency limits, while the results of the smoothing approximation for the Dyson and Bethe–Salpeter equations are limited to the low-frequency limit. In addition, it was also concluded that the secular effects that exist in the ordinary Born series may be fictional. (auth)

40034 PROPAGATION OF A FREQUENCY MODULATED ELECTROMAGNETIC WAVE IN A LORENTZIAN PLASMA. Kahan, Theo (Univ., Paris); Allanche, J. D.; Jancel, Raymond. Compt. Rend., Ser. B; 274: No. 8, 528-31(21 Feb 1972). (In French).

The propagation equation is solved in view of obtaining an expression for the electric field inside a Lorentzian plasma in which two superposed electromagnetic waves (one being frequency modulated) are propagated. The nature of the nonlinear phenomena appearing is analyzed. (France)

40035 INVESTIGATION OF TWO TYPES OF COLLISIONLESS LINEAR DAMPINGS OF ELECTROMAGNETIC WAVES IN A NONHOMOGENEOUS MAGNETIZED PLASMA. Castro Blanco, J.; Golovanivskii, K. S.; Zambrano Cifuentes, E. (Patrice Lumumba Univ., Moscow). Phys. Lett.; 39A: No. 5, 368-70(5 Jun 1972).

The space damping of EM waves in a magnetoactive plasma caused by the electron cyclotron resonance (ECR damping) and the damping as a result of linear transformation of waves (LTW damping) was experimentally measured. It was found that, under identical conditions, the ECR damping is considerably more effective than LTW damping. (auth)

40036 COMPUTER STUDIES OF CURRENT-DRIVEN ION-SOUND TURBULENCE IN THREE DIMENSIONS. Biskamp, D.; Von Hagenow, K. U.; Welter, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Lett.; 39A: No. 5, 351-2(5 Jun 1972).

First results of 3-dimensional computer simulations of ion-sound instability are reported. As compared with the 2-dimensional system, studied previously, the turbulent resistivity here is larger by a factor of 2 to 3 and is consistent with a simple model of stochastic electron heating. (auth)

40037 VOLNY V MAGNITOAKTIVNOI PLAZME. (Waves in Magnetoactive Plasma). Ginzburg, V. L.; Rukhadze, A. A. Sovremennye Problemy Fiziki. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1970). 208p.

The theory of the propagation of electromagnetic waves in a plasma, and general questions of linear electrodynamics of media with spatial dispersion, are considered. Various models are employed in describing a collisionless plasma, and collisions of particles in completely ionized and weakly ionized plasmas are examined. The dielectric permeability of isotropic and homogeneous plasmas in the absence of external fields is discussed in detail. (58 references) (K.S.W.)

40038 TRANSMISSION AND REFLECTION OF A WAVE OBLIQUELY INCIDENT ON A NONUNIFORM MAGNETIZED PLASMA. Peratt, A. L.; Kuehl, H. H. (Univ. of Southern California, Los Angeles). Radio Sci.; 7: No. 2, 309-23(Feb 1972).

A theory is given describing the conversion of obliquely incident fast waves to slow waves when propagation is perpendicular to a static magnetic field in a warm inhomogeneous plasma for frequencies near and below the second electron cyclotron harmonic. The half-space and thin slab are treated with collisional effects included. The results are compared with those of a previously considered normally incident wave case. In particular, the analysis points out that wave conversion is proportional to the scale length of the density gradient at a hybrid resonance point, provided the scale length is small compared to a free-space wavelength. Both analytical and numerical solutions for the reflection and transmission coefficients and fields within the slab are presented. Between the hybrid resonances the electric field is found to consist of a longitudinal Bernstein-mode contribution with rapid spatial variation and a slow-variation extraordinary-mode contribution. With appreciable losses, a pure standing wave is predicted at the center of the plasma whereas, near the hybrid resonance points, the longitudinal field is predominantly a traveling wave with an outwardly directed phase velocity. Although the coupling is small, the longitudinal field attains a large amplitude, producing strong reflection of the incident wave when resonances occur with even symmetry about the center of the slab. Furthermore, the numerical computations indicate a perturbation in the position of the resonances from those of the normally incident case. This shift is analogous to the azimuthally asymmetric modes of a plasma column. Finally, for a large angle of incidence, the formulation leads to the impedance of a nonuniform plasma capacitor in a magnetic field. (auth)

40039 COMPUTATION OF DISPERSION CURVES FOR A HOT MAGNETOPLASMA WITH APPLICATION TO THE UPPER-HYBRID AND CYCLOTRON FREQUENCIES. Muldrew, D. B.; Estabrooks, M. F. (Communications Research Centre, Ottawa). Radio Sci.; 7: No. 5, 579-86(May 1972).

Rapid calculations of the dispersion relation can be made for a hot, Maxwellian electron magnetoplasma, with collisions and for any angle β between the wave normal and static magnetic field without using the low-temperature or the quasi-static approximations. The dispersion equations of Lewis and Keller (1962) are discussed and interpreted for the purpose of computer programming; these equations are valid for a Vlasov–Maxwellian plasma and contain a particle-preserving collision term. Examples of dispersion curves for homogeneous plane waves show: (1) protrusions from some refractive-index surfaces and (2) the usual multiplicity of solutions for a Maxwellian plasma when the real and imaginary components of the refractive index are of similar magnitude. For a wave frequency 1.11 times the plasma frequency and about 1.78 times the gyrofrequency, a minimum is found in the collisionless damping at $\beta = 0°$ and a maximum is found at about $\beta = 14°$. Three alternatives for the gyroresonance observations on topside ionograms can be found from a study of the dispersion curves near the gyrofrequency: (1) an energy transfer between the highly damped whistler mode and electrons in the vicinity of the sounder, (2) the field resulting from the multiplicity of solutions mentioned above, and (3) an evanescent field. (auth)

40040 PERTURBATION CALCULATION OF THE SCATTERING OF ELECTROMAGNETIC WAVES BY AN UNDERDENSE PLASMA LAYER. Klein, Milton M. (Air Force Cambridge Research Lab., Bedford, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-20: No. 1, 78-80(Jan 1972).

A perturbation technique is utilized to obtain the scattering of electromagnetic waves by an underdense plasma layer for Gaussian, sech, and parabolic density distribution, and the calculations compared with accurate solutions. The results for the reflection are good at small values of plasma width, but (except for the parabolic case) decrease too rapidly at large plasma widths. The transmission coefficient is more difficult to calculate and, despite the presence of absorption, has a spurious rise to unity at large plasma widths. A Wentzel—Kramers—Brillouin calculation of the transmission yields fairly accurate results and with less labor than required by the perturbation method. (auth)

40041 PHASE AND GROUP VELOCITY IN A DRIFTING MAGNETOPLASMA. Singh, Nagendra (Univ. of Iowa, Iowa City). Contract AT(11-1)-2059. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-20: No. 1, 77-8(Jan 1972).

The relationship between group and phase velocities of electromagnetic waves in a drifting uniaxial plasma is discussed. When determining whether propagation between two points is possible, the allowed direction of the group velocity vector and not that of the phase velocity is important. (auth)

40042 SHOCK-WAVE STRUCTURE IN AN IONIZED GAS. Lu, Chien-shiong. Atlanta; Georgia Inst. of Tech. (1971). 226p. University Microfilms Order No. 72-5065.

Thesis.

The discrete ordinate method is applied to the solutions of a shock-wave structure in fully or partially ionized argon and the relaxation zone of a shock wave. The effects of the electric field induced by the charge separation on the shock-wave structure are also investigated. The Boltzmann equations with a kinetic-model type of collisions are employed as the governing equations. The results are compared with limited experimental measurements and other theoretical treatments, either by continuum approaches or by the Mott—Smith method. (TSS) (Diss. Abstr. Int., B)

40043 COUPLING OF ELECTRON PLASMA AND ION SOUND WAVES IN A SMALL MAGNETIC FIELD. Gratzl, H. (Institut fuer plasmaphysik, Garching, Ger.). Acta Phys. Austr.; 34: No. 1-2, 162-72(1971).

Resonant coupling of two electron plasma waves with an ion-sound wave is slightly changed for large electron Larmor radii ρ. A small increase of the order $(k_\perp/k)^2_{el.pl.} \times \lambda_e^2/\rho^2$ (λ_e being the Debye length) is found except for very large wavelengths of ion-sound waves perpendicular to the magnetic field, in which case the coupling is decreased. (auth)

40044 NONLINEAR EXCITATION OF ION SOUND WAVES. Gratzl, H. (Univ., Innsbruck). Acta Phys. Austr.; 34: No. 3, 221-6(1971).

The excitation of ion—sound waves through resonant coupling with enhanced electron plasma waves is shown to increase slightly in the course of time, if the reaction of the electrons is taken into account. The coupling coefficient is affected strongly in explosively unstable situations but, from particle energy considerations, there follows a limitation in time for the validity of the kinetic equations for unstable negative energy waves. (auth)

40045 10.6-μm LASER SCATTERING FROM CYCLOTRON-HARMONIC WAVES IN A PLASMA. Surko, C. M. (Bell Telephone Labs., Murray Hill, N. J.); Slusher, R. E.; Moler, D. R.; Porkolab, M. Phys. Rev. Lett.; 29: No. 2, 81-4(10 Jul 1972).

Scattering of CO_2-laser light from driven cyclotron-harmonic waves in a collisionless plasma of density 4×10^{10} cm^{-3} was studied. Using light-mixing spectroscopy, scattering from waves with frequencies of several hundred megahertz, wavelengths from 2.0 to 0.75 mm, was observed, as well as associated fractional electron-density modulations as small as 10^{-5}. (auth)

40046 ION-SOUND OSCILLATIONS OF A PLASMA CYLINDER IN A MAGNETIC FIELD. Pankratov, I. M.; Stepanov, K. N. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 12, 1979-84(Dec 1971). (In Russian).

Ion-sound oscillations of a plasma cylinder in a uniform magnetic field are considered. It is shown that surface acoustic waves exist parallel with fast and slow volume acoustic waves. (auth)

40047 EXCITATION OF FAST ELECTRON CYCLOTRON WAVES IN A NONEQUILIBRIUM PLASMA. Sinitsa, N. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1801-3 (May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2266-70(Nov 1971).

The excitation of electron cyclotron oscillations propagated across a magnetic field in a uniform infinite nonequilibrium plasma is examined in the linear approximation. (auth)

40048 PLASMA PENETRATION NEAR THE LOWER HYBRID FREQUENCY. Golant, V. E. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 1980-8(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2492-2503(Dec 1971).

Penetration of electromagnetic waves into a magnetized plasma is discussed for frequencies near the lower hybrid frequency; the electromagnetic waves are transformed into slow, highly damped plasma waves. Conditions for wave penetration into homogeneous and inhomogeneous magnetic fields are analyzed and the coupling efficiency is discussed. (auth)

40049 MICROWAVE ABSORPTION IN A PLASMA INHOMOGENEOUS IN THE DIRECTION OF THE MAGNETIC FIELD. Arkhipenko, V. I.; Budnikov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 11, 1858-64(May 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 11, 2341-9(Nov 1971).

Microwave absorption was investigated in a plasma highly inhomogeneous in the direction of the magnetic field. The plasma is generated by 3-cm microwave power; conditions for the electron cyclotron resonance obtain at the end section of a long narrow cylinder (2.5 cm in diameter and 70 cm long) filled with argon at 10^{-2} mm Hg. An exponentially decreasing longitudinal density gradient is set up in the central portion of the cylinder. A 10-cm waveguide perpendicular to the cylinder axis is used to supply microwave power at 2370 MHz (0.01 to 10 W) to this region of the plasma; the high-frequency electric field is perpendicular to the magnetic field. The plasma parameters are as follows: $n = 10^{10}$ to 10^{12} cm^{-3} and T_e = 2 to 2.5 eV; the conditions $\omega_{He} \approx 3\omega$ and $\omega_p \lesssim \omega$ hold. One observed effective absorption (up to 60%) with moderate supercritical densities in the 10-cm waveguide ($n_c = 7 \times 10^{10}$ cm^{-3}). An increase in the density of the initial plasma, hence the loss of the wave energy, occurs 10 to 25 cm from the 10-cm waveguide. The region of microwave absorption is localized near the cross section for which the maximum cross-sectional density n_0 is equal to the critical density n_c and is displaced along the cylinder with this section. For these experimental conditions, a plasma waveguide is formed, waves propagating along it without noticeable attenuation to the region where $n_0 \approx n_c$. The position of the wave-absorption region is discussed on the basis of the theory of wave conversion in a plasma with a two-dimensional inhomogeneity. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 38517, 39046, 39063, 39402, 39792, 39872, 40084, and 40101.

40050 (HASL–254) COSMIC-RAY DOSE RATES IN THE ATMOSPHERE. Lowder, Wayne M.; O'Brien, Keran (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr 1972. 11p. Dep. NTIS.

A critical summary of existing data on total air ionization and tissue dose rate from cosmic radiation in the atmosphere is presented. (auth)

40051 (HMI-B–117) IONIZATION OF DIELECTRIC LIQUIDS BY HIGH ENERGY RADIATION STUDIED BY MEANS OF ELECTRICAL CONDUCTIVITY METHODS. Hummel, A.; Schmidt, W. F. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany). Interuniversitair Reactor Instituut, Delft (Netherlands)). Dec 1971. 172p. (IRI–133–71–19). Dep. NTIS (U. S. Sales Only).

The action of high-energy radiation on dielectric liquids is reviewed, especially hydrocarbons (i.e., liquids with a dielectric constant ≈ 2). Measurement techniques for liquid rare gases are included, while the results are presented in a general fashion. Models for the problem of track structure, spatial distribution of ions and electrons, and lifetime of ions in the track are discussed. Special attention is given to the effects of high LET radiation. The theory of transport properties was developed only for electrons and ions in rare gas liquids. (M.H.R.)

40052 (TRITA-EPP–71–22) MULTIPLE SCATTERING OF RELATIVISTIC ELECTRONS IN AIR. Brahme, Anders (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). 4 Oct 1971. 35p. Dep. NTIS (U. S. Sales Only).

The multiple scattering of a narrowly collimated electron beam from a 6-MeV microtron accelerator was studied when the electrons are entering into air at atmospheric pressure and room temperature. Due to the high intensity of the beam, direct measurement of the electron current to a small copper target was possible. The lateral distribution of electron density has been measured in air at distances up to 2 meters from a thin aluminum window. The experimentally obtained distributions are compared with present theories of multiple scattering. The application of the results to high-energy electron therapy is discussed, with special reference to the scanning-beam method. (3 tables, 12 figures, 26 references) (auth) (Sweden)

40053 MULTIPLE SCATTERING OF HEAVY IONS IN STRIPPER FOILS. Andersen, H. H.; Boettiger, J. (Univ. of Aarhus, Denmark). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 274-5(Apr 1972).

From International conference on multiply-charged heavy ion sources and accelerating systems; Gatlinburg, Tenn. (25 Oct 1971). See CONF-711021.

Meyer's calculations of angular distributions of multiple scattering in the stripping of heavy ions by gases and solids were tested for 18 elements between Li and Zn in C and 14 elements between He and Ar in Au. Energies ranged from 0.15 to 1.0 MeV. For C E^{-1} scaling was fulfilled. Experimental and theoretical reduced half-widths are shown for several ions in C; the complete results have been published in Phys. Rev. B, 4, 2105(1971). (1 figure) (R.W.R.)

40054 LOW-ENERGY ELECTRON TRANSPORT BY THE METHOD OF DISCRETE ORDINATES. Bartine, D. E.; Alsmiller, R. G. Jr.; Mynatt, F. R.; Engle, W. W. Jr.; Barish, J. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 48: No. 2, 159-78(Jun 1972).

The one-dimensional discrete ordinates code ANISN has been adapted to simulate the transport of low-energy (on the order of a few MeV) electrons. Two different calculational techniques have been utilized for the treatment of electron–electron collisions that result in a small energy transfer. One method treats such collisions by a continuous slowing down approximation, while the other method treats these collisions by the use of a very approximate cross section. Calculated results obtained with ANISN are compared with experimental data for the transmitted energy and angular distributions for 1-, 2.5-, 4-, and 8-MeV electrons normally incident on aluminum slabs of various thicknesses and for 1-MeV electrons normally incident on a gold slab. The calculated and experimental results are in reasonably good agreement for the aluminum slabs but are in poor agreement for the gold slab. Calculated results obtained with ANISN are also compared with calculated results obtained with Monte Carlo methods. (auth)

40055 TREATMENT OF A CYLINDRICAL GAP BY TRANSPORT THEORY. Haring, Guenter (Technische Hochschule, Graz). Acta Phys. Austr.; 33: No. 3-4, 251-62(1971). (In German).

The Boltzmann equation for a cylindrical gap is solved by spherical harmonics method. A method for the solution of the differential equation system, which is the result of the P_n approximation method applied to Boltzmann equation, is described. This technique permits the system to be solved also in those cases in which not all spherical harmonics components of the vector flux are independent of each other. In particular, the neutron distribution in a two-dimensional cylindrical gap is calculated by the P_2 approximation of the Boltzmann equation. Introducing the linear combination of special functions, which depend on a parameter, the resulting differential equation system is reduced to a linear equation system for some coefficients. This system is solved and the total solution of Boltzmann equation is calculated explicitly. (auth)

40056 FLUCTUATIONS IN THE ENERGY LOSS OF 66- AND 100-MeV PROTONS IN A THIN PROPORTIONAL COUNTER. Huetter, G. T.; Madey, R.; Yushak, S. M. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Rev., A; 6: No. 1, 250-5(Jul 1972).

Fluctuations in the energy loss were measured for 66- and 100-MeV protons passing through a proportional counter filled with 11.0 mg/cm^2 of a gas mixture of 90% xenon plus 10% methane. The measured values are consistent with the theoretical values determined from the Vavilov theory for energy-loss fluctuations; however, when the Vavilov theory is corrected for the binding effect of the electrons based on the formulation of Shulek et al., the corrected theoretical energy-loss distributions do not agree with the experimental distributions. (auth)

40057 ENERGY LOSS OF FISSION FRAGMENTS IN COMPOSITE SYSTEMS. Hakim, M.; Shafrir, N. H. (Technion-Israel Inst. of Tech., Haifa). Nucl. Sci. Eng.; 48: No. 1, 72-7(May 1972).

Accurate predictions of the energy loss of fission fragments in gaseous and solid stopping media are of considerable interest in a number of fields such as fissio-chemistry and direct energy conversion in fission–electric cells. In practical systems the energy deposition occurs not only in elementary substances, but mostly in chemical compositions, mixtures, or alloys. Experimental energy-loss data for ^{252}Cf fission fragments in a number of gaseous compounds are presented. These data are compared with predicted energy-loss data obtained by applying a modified semi-empirical energy-loss expression for the constituent elementary substances and by making use of the Bragg law of additivity of atomic stopping powers, yielding good agreement with experiment. Results obtained for energy loss in gaseous compounds consisting of both gaseous and solid components stress the conclusion that, within experimental uncertainties, the energy loss of fission fragments is independent of the physical state of the stopping medium. Thus, a reliable and accurate method for estimation of fission-fragment energy losses in composite systems of technological interest is provided. A commonly used method for estimating fission-fragment ranges in composite materials was tested, and the deviation thus obtained was determined. (auth)

40058 ADJOINT DIFFERENCE METHOD AND ITS APPLICATION TO DEEP-PENETRATION RADIATION TRANSPORT. Hoffman, T. J.; Robinson, J. C.; Stevens, P. N. (Univ. of Tennessee, Knoxville). Nucl. Sci. Eng.; 48: No. 2, 179-88(Jun 1972).

An important radiation transport problem is that of determining the effect of a geometrically complex object (vehicle) located in an otherwise geometrically simple system. The direct solution to this problem often requires a Monte Carlo calculation. If the vehicle is far removed from the radiation source, the calculation can be very costly or even impossible. To deal with this problem, a new method, the adjoint difference method, has been developed. This method decomposes the original problem into two independent calculations: (1) a geometrically simple (one- or two-dimensional) deep-penetration calculation that is independent of the vehicle, and (2) a localized three-dimensional calculation that is independent of the radiation source. The first calculation is suitable to deterministic methods of solution, such as discrete ordinates. The second, by nature of geometry, usually requires a Monte Carlo calculation; however, this is not a deep-penetration calculation. Therefore, the dual complexity of geometry and statistics inherent in a deep-penetration Monte Carlo calculation is avoided. Since the above calculations are independent, only the coupling of these calculations depends on the relative position and orientation of the source and vehicle. Hence, the effects of different sources and arbitrary vehicle orientations can be obtained from a single Monte Carlo calculation. The method was examined through application to several problems. All results were compared to those obtained from presently acceptable methods of problem solution. In these applications, the adjoint difference method was shown to be an efficient, versatile method of calculation. (auth)

40059 ABNORMAL STOPPING POWER OF PROTON AND ION CHANNELING. Ohtsuki, Y. H.; Kitagawa, M.; Mizuno, M. (Waseda Univ., Tokyo). Phys. Status Solidi (b); 51: No. 1, K19-21(1 May 1972).

An interpretation of a formula proposed by Robinson (Phys. Rev., 179: 327(1969)) for the stopping power under channeling conditions is presented briefly. It is concluded that the weak position dependence of the local stopping power is explained by the exchange effect of core electron excitations for the local absorption coefficient and by the local ionization energy combined with the plasmon excitation energy. (A.G.W.)

40060 ANOMALOUS STRAGGLING OF ALPHA PARTICLES IN ALUMINIUM COMPARED TO OTHER ABSORBERS. Sykes, D. A.; Harris, S. J. (Univ. of Surrey, Guildford, Eng.). Nucl. Instrum. Methods; 101: No. 3, 423-5(1972).

Energy-straggling measurements were carried out for ^{241}Am alpha particles transmitted through various thicknesses of Al, Cu, Ag, Au, and Melinex. The expected increase of energy straggling with atomic number was found for all materials with the exception of aluminum, which produced an anomalously high value. Melinex was chosen as having an effective atomic number close to that of air. Good agreement is shown between results for air and Melinex. (auth)

40061 MONTE CARLO CALCULATION OF THE SELF-ABSORPTION OF GAMMA RAYS IN A DISC SHAPED SOURCE. Peterman, B. F. (Univ. of Saskatchewan, Regina). Nucl. Instrum. Methods; 101: No. 3, 611-12(1972).

A Monte Carlo program has been developed by means of which one can calculate the self-absorption of gamma rays in a disc-shaped source. The program was used to calculate the self-absorption of the energy lines of the sources ^{57}Co, ^{203}Hg, and ^{137}Cs. (auth)

40062 RESONANT RADIATION OF RELATIVISTIC ELECTRONS IN PERIODIC INHOMOGENEOUS MEDIA. Arutyunyan, F. R.; Kishinevskii, V. P.; Nazaryan, A. A.; Torgomyan, G. B.; Frangyan, A. A. (Inst. of Physical Research, Erevan). Dokl. Akad. Nauk Arm. SSR; 52: No. 4, 216-20(1971). (In Russian).

Synchrotron-generated electrons with energies of 2.8 and 3.7 GeV were studied in different laminated media, each layer of which was separated by an air space of a certain thickness. The angular distribution of the radiation was measured, and the experimental spectra were compared with the theoretical, calculated according to a formula involving resonance. Interference of the radiation was observed at different boundaries of the laminated media. Measurements on 2.8- and 3.7-GeV electrons showed that multiple scattering was observed only for laminated media that contained comparatively thick layers. (K.S.W.)

40063 REFLECTION OF ELECTRONS FROM A PLANE ELECTROMAGNETIC WAVE IN A MEDIUM. Arutyunyan, V. M.; Avetisyan, G. K. (Inst. of Physical Research, Erevan). Dokl. Akad. Nauk Arm. SSR; 52: No. 4, 221-3(1971). (In Russian).

The development begins with an electron with a given initial velocity moving in the direction of propagation of an electromagnetic field in a medium. The character of motion of the electron is a function of 2/mc, the voltage potential of the field, and the wave frequency, as well as the other initial conditions. If the electron overtakes the wave, the electron loses energy due to interaction with the wave. Conditions are described whereby the electron in the medium would absorb photons, thereby increase its energy and detach itself from the wave (reverse Cherenkov effect). If the wave is at rest, the electron is incident to the wave, and under certain conditions will be reflected from the wave. (K.S.W.)

40064 THEORY OF EFFECTIVE CHARGE AND STOPPING POWER FOR HEAVY IONS. Sauter, George D. (Univ. of California, Davis); Bloom, Stewart D. Phys. Rev., B; 6: No. 3, 699-712(1 Aug 1972).

A revision of the Knipp–Teller effective-charge theory for the electronic stopping power of media for heavy ions is described. In the new theory the ion velocity is related to the mean ionization energy of the most loosely bound medium electrons as calculated from the Thomas–Fermi atomic model. The effective charge (γz, $0 < \gamma < 1$, where γ is the effective-charge parameter) of an ion with atomic number z is related to the ionic kinetic energy ϵ(MeV/amu) through the equation $\epsilon/z^{4/3} = 0.0277k[f_0(\gamma) + f_1(\gamma)/z]$ MeV/amu, where k is a constant, near unity, to be determined from the empirical data for the atomic-number region of interest. Curves for f_0 and f_1 as functions of γ are presented and an overall value of $k = 1.25$ is recommended. Calculated values of the effective-charge parameter are compared to experimentally measured values for a wide range of ions, ionic energies, and stopping media. For $z > 10$ the agreement is very good from $\epsilon/z^{4/3} \approx 0.001$, where exchange corrections (ignored in the Thomas–Fermi model) become important, to $\epsilon/z^{4/3} \approx 0.1$, where a statistical theory is no longer valid. (auth)

40065 RELATIVE ABUNDANCES OF MULTIPLY CHARGED NEON, ARGON, AND KRYPTON IONS FOLLOWING PHOTOIONIZATION BY X RAYS. Lightner IV, George Samuel. Charlottesville, Va.; Univ. of Virginia (1971). 108p. University Microfilms Order No. 72-7192.

Thesis.

Relative abundances of multiply charged neon, argon, and krypton ions produced by x rays of energies 0.28, 1.49, 5.42, and 8.03 keV were measured with a pulsed time-of-flight mass spectrometer. Effectively monoenergetic x rays were obtained by a filtering technique whereby two filters with transmissions matching at all energies except at the K characteristic line of the x-ray tube target material were alternately placed in the x-ray beam. The data when corrected for charge dependent discrimination effects are consistent with previous measurements, and except for neon, with calculations that include the electron shake-off mechanism in addition to Auger transitions. The results for neon at 0.28 keV confirm the need for including additional mechanisms such as direct double ionization in the description of the ionization process. Other discrepancies between theory and experiment can be explained by considering the energy dependence of partial photoionization cross sections calculated by Rakavy and Ron. (Diss. Abstr. Int., B)

40066 PERTURBATION CALCULATIONS IN TRANSPORT THEORY APPLIED TO LOCAL PERTURBATIONS. Timischl, W. (Univ., Graz). Acta Phys. Austr.; 34: No. 4, 301-12(1971).

The Rayleigh–Schroedinger perturbation method is applied to the perturbed Boltzmann equation of a slab reactor. It turns out that the nth-order neutron flux can be expanded into a series of eigenfunctions of the corresponding unperturbed Boltzmann equation. Numerical claculations are performed in first- and second-order perturbation theory. The perturbations dealt with are local ones. The results are also compared with those of the diffusion theory. (auth)

40067 OPTIMIZATION OF RADIATION LOOP PARAMETERS FOR OBTAINING MAXIMUM GAMMA-RADIATION DOSE RATE. Gavar, V. V.; Dindun, A. S.; Tomson, E. Ya.; Kheninya, I. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 1, 13-17(1972). (In Russian).

A technique is developed for calculating the optimum radiation circuit parameters for gamma sources to ensure the maximum dose rates in cylindrical sources. The technique enables self-screening of the gamma carrier in the generator to be accounted for, as well as self-absorption in the radiation source. The optimum parameters of radiation circuits with radiation sources of the most commonly used sizes are given. (auth)

40068 CLASSICAL MICROSCOPIC THEORY OF THE RADIATION OF A CHARGE MOVING ALONG A SPIRAL PATH AND THE METHOD OF GREEN'S FUNCTIONS. Konstantinovich, A. V. (Chernovits State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 145-7(1971). (In Russian).

The total electric loss of a charge in a vacuum and the spectral distribution of these losses in the medium were found, using the concept of the force of self-action. The medium was assumed to be an ideal dielectric, with unit permeance, but the following were neglected: dispersion, multiple Coulombic deceleration, ionization, and excitation of matter. With the concept of a charge moving spirally with constant velocity in a magnetic field in a medium the electric losses are represented in synchronous and Cherenkov radiation. Mathematical treatment is concerned with a field produced by a particle at the point of its location, and the method of Green's function. Second, the energy loss by the charge and the force of self-action is treated. These equations may be applied to the energy loss of charges in a plasma. (K.S.W.)

40069 SOME DIFFICULTIES INHERENT IN THE MEASUREMENT OF RADIOACTIVITY IN NUCLEAR MEDICINE. Kenny, Peter J. (Univ. of Miami, Fla.). pp 133-6 of Hematopoietic and Gastrointestinal Investigations with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1972).

From Hematopoietic and gastrointestinal investigations with radionuclides conference; Miami, Fla. (3 Mar 1971).

Difficulties associated with the measurement of radioactivity in nuclear medicine are of two principal types: those resulting from the statistical nature of nuclear decay and those relating to technical resolutions of instruments used (they, for the most part, have no depth perception). A tomographic approach can be used to eliminate the latter difficulty to some extent, but it encounters serious obstacles of the former type. Short-lived tracers can reduce statistical fluctuations, but only if their half-lives are comparable to the biological time scale of the process studied. (1 table) (R.W.R.)

40070 INEQUALITY FOR CONVEX FUNCTIONS IN QUANTUM-STATISTICAL MECHANICS. Okubo, S. (Univ. of Rochester, N. Y.); Isihara, A. Physica; 59: No. 2, 228-40(15 May 1972).

From an inequality for a convex function of two hermitian operators, the Peierls and Gibbs operators, coarse graining and other important inequalities are derived in a unified way. Various different forms of the basic inequality are given. They are found useful in discussing the entropy and other physical problems. Special accounts are given of functions such as exp x and x log x. (auth)

40071 THEORY OF A DEGENERATE ELECTRON FERMI LIQUID IN A MAGNETIC FIELD. Kondrat'ev, A. S.; Kuchma, A. E. Vestn. Leningrad. Univ., No. 10, Fiz., Khim.; No. 2, 29-33(May 1971). (In Russian).

The kinetic equations of the Landau–Silin theory of the electron Fermi-liquid were shown to be applicable in the presence of a strong magnetic field, while quasiparticles with classical dispersion law may be introduced in quantizing magnetic field. (auth)

40072 KINETIC AND ERGODIC PROPERTIES OF QUANTUM SYSTEMS: THE FRIEDRICHS MODEL. Grecos, A. P. (Univ. Libre, Brussels); Prigogine, I. Physica; 59: No. 1, 77-96(1 May 1972).

The irreversible phenomena in the interior of a system characterized by a Hamiltonian having a continuous spectra are studied with the help of the methods of nonequilibrium statistical mechanics. In particular, the connection is shown between the possibility of a kinetic description and the nature of the invariants of the system. This reformulation of the ergodic problem allows one to deal with this question for systems with an infinite number of degrees of freedom. (tr-auth)

40073 VACUUM CHAMBER TO STUDY THE LUMINESCENCE EMISSION FROM LIQUIDS AND LOW TEMPERATURE GLASSES FOLLOWING ELECTRON IRRADIATION. Smith, G. J.; Lillicrap, S. C.; Fielden, E. M. (Inst. of Cancer Research, Sutton, Eng.). J. Phys., E (London); 5: No. 7, 686-8(Jul 1972).

A stainless steel vacuum chamber was designed for the observation of luminescence emission from liquid or solid samples in the temperature range 80 to 380°K following irradiation by pulses of high energy electrons. The samples may be irradiated in the presence of any gas at pressures between 1 μtorr and 760 torr. At low pressures and temperatures radiative heating of the sample becomes important and leads to thermal gradients in the sample. This effect was investigated and reduced by the use of a cooled "heat shield." (auth)

40074 SIZE DISTRIBUTION OF ION CLUSTERS ALONG CHARGED PARTICLE TRACKS IN GASES. Ore, Aa. (Univ. of Oslo). Phys. Norv.; 5: No. 3-4, 259-65(1971).

The discrepancy that exists between the much-used relative frequencies observed by Wilson and by Beekman, respectively, for radiation-induced ion clusters containing various numbers of ion pairs per cluster is discussed. A presumed difference in the influence of the merging by diffusion of adjacent clusters offers a quantitative explanation for this discrepancy. This conclusion supports the previous findings of Ore & Larsen, who based their overlap-correction procedure on a somewhat less sophisticated theoretical model, however. (auth)

40075 DOSE DISTRIBUTION BEYOND THE GEOMETRICAL LIMITS OF A BEAM OF γ RADIATION. Belov, S. A.; Kaveshnikova, S. V.; Sizov, P. P.; Ratner, T. G. (Moscow Municipal Hospital). Med. Radiol.; 17: No. 2, 57-60(Feb 1972). (In Russian).

Measurements of 1 to 10% isodose are presented for various sizes of a square field. After a study of the large dependence of the contribution of scattered radiation on the size and side ratios of the field at depths of over 5 cm, it is recommended that the dimensions of the field be measured according to its geometrical limit, and not according to the dimensions of any particular isodose. (tr-auth)

40076 CALCULATION OF BUILDUP FACTORS FOR γ-RADIATION FROM NONSTATIONARY SOURCES. Seleznev, N. A. This paper was summarized in At. Energ. (USSR); 31: No. 3, 271-2 (Sep 1971) as paper No. 526/6088. (In Russian).

Full copy of this paper is held by TIC.

The salient features of the transport of γ radiation from a nonstationary source in an infinite homogeneous medium whose properties do not vary with time are considered. It is shown that the transient processes that develop are determined partly by the time variation of the γ source and partly by the delay of secondary (scattered and regenerated) γ radiation relative to the noninteracted flux from the source. By taking the Laplace transform of the equation describing the transport of radiation from a nonstationary γ source in a real medium, a system of stationary transport equations for a certain fictitious medium can be derived. By using known solutions of the transport equation for the stationary case and assuming that they are the Laplace transforms of the required nonstationary solution, the corresponding characteristics of the required nonstationary transport process can be recovered by taking the inverse Laplace transform. Such an analysis was performed for a pulsed γ source described by a Dirac δ function. (M.H.R.)

40077 DOSE DISTRIBUTION OF NONEQUILIBRIUM ELECTRONS AT THE INTERFACE SEPARATING MEDIA IN γ-IRRADIATION. Antsilevich, M. G.; Lenchenko, V. M.; Sofienko, L. A. This paper was summarized in At. Energ. (USSR); 31: No. 3, 271 (Sep 1971) as paper No. 525/6244. (In Russian)

Full copy of this paper is held by TIC.

When the interface separating media of different atomic number and different moderating powers is exposed to γ radiation, the flux and spectrum of Compton electrons and photoelectrons is not compensated by a back flow of electrons. Calculations of the nonuniformity in energy absorption at the interface due to this effect are presented. A power-law relationship between path length and energy for electrons and rectilinear electron trajectories are assumed. Numerical analysis of the formulas was carried out on a computer. (M.H.R.)

40078 EMPIRICAL FORMULA, CONTINUOUS IN FIELD PARAMETERS AND DEPTH, FOR THE AXIAL DOSE FOR ^{60}Co GAMMA RADIATION. Benassi, M.; Paoluzi, R. (Regina Elena Inst. for Cancer Research, Rome). Brit. J. Radiol.; 45: No. 534, 475(Jun 1972).

A fairly simple empirical expression is presented, enabling the axial dose for ^{60}Co γ radiation to be calculated in radiotherapy for any values of depth, field dimension, and source-to-surface distance. The expression was derived from a computer analysis of depth dose data, and its constants obtained by least-squares fitting to the percentage depth doses given in the standard tables. The full expression ensures agreement with the tabulated values to better than 0.9% (standard deviation 0.3%). A simplified expression gives maximum error of less than 2% (standard deviation 0.6%). (UK)

40079 SPECTRUM OF γ-RAY SCATTERING AT SMALL DISTANCES FROM THE SOURCE. Utkin, V. I. This paper was summarized in At. Energ. (USSR); 29: No. 7, 38 (Jul 1970) as paper No. 405/5653. (In Russian).

Full copy of this paper is held by TIC.

The spectral distribution of multiple scattering of γ quanta from a source located in a homogeneous dispersive–absorptive medium possesses a sharply expressed maximum that results from two competitive processes: reduction of γ quantum energy by Compton scattering and photoabsorption. The phenomenon of inversion was observed when a state of conventional equilibrium had not been reached. An increase in the scattering density under these conditions induces an increase in the intensity of γ quanta in the relatively soft portion of the scattered γ radiation and a decrease in the relatively hard part. The phenomenon of inversion is observed in the event that these changes in the soft and hard regions of the spectrum are equal. (K.S.W.)

40080 IONIZATION CASCADE IN HELIUM CAUSED BY NONRELATIVISTIC ELECTRONS. Alkhazov, G. D. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 12, 1995-2002(Jun 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 12, 2513-23(Dec 1971).

The ionization cascade due to electrons with an initial energy $E \leq 2.5$ keV in helium is analyzed. The following are determined: the average energy per ion–electron pair ($W = 46$ eV); the Fano constant ($F = 0.21$); the average numbers of different excited atomic states in deceleration; the photon spectrum produced in the decay from excited states to metastable states; the electron degradation spectrum (including the subthreshold spectrum); W and F as functions of the probability of additional ionization in the absence of excitation. (auth)

Radiation Protection Standards

40081 (UCRL-72981) EVALUATION OF RADIATION HAZARDS FROM HIGH-VOLTAGE VACUUM INTERRUPTERS. Greenhouse, N. A.; Peterson, G. C. (California Univ., Livermore. Lawrence Livermore Lab.). 16 Aug 1971. 22p. (CONF-710710-11). Dep. NTIS.

From sixteenth annual Health Physics Society meeting; New York, N. Y. (12 Jun 1971).

High-voltage vacuum interrupters are electromechanical relays frequently used to control dc, ac, and rf currents at potentials up to about 100 kV. With high potential differences impressed across the open electrodes, these devices can become potent x-ray generators. The principal source of x rays is apparently field emission of electrons from the cathode. Additional electrons may be produced by ionization of residual gas and subsequent ion bombardment of the cathode. X-ray fields of the order of tens of roentgens per hour at 1 m were produced from interrupters operated within their maximum voltage rating. The production of x rays is correlated with electrode condition and alignment, gap distance, and envelope pressure. (auth)

40082 NEW MODEL FOR ESTIMATING SPACE PROTON DOSE TO BODY ORGANS. Langley, R. W.; Billings, M. P. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). Nucl. Technol.; 15: No. 3, 68-74(Jul 1972).

It has been presumed that geometrically faithful man models are required to accurately account for the effect of body self-shielding on space radiation dose to radiation-sensitive organs other than the skin and lens of the eye. It is demonstrated that a simple equivalent sphere model reproduces the results of comprehensive dose analyses that employ a detailed man model, with an accuracy sufficient for dose assessments. A correlation has been established analytically that holds for the full range of observed solar proton spectra and for a range of vehicle shielding worths from zero to 10 g/cm^2 of aluminum. Equivalent sphere model parameters are presented for the blood forming organs, the gastro-intestinal tract, and the testes. (auth)

Radiation Source Calibration and Standardization

Refer also to abstracts 38442 and 40061.

40083 (JAERI-M-4578) CALCULATION OF THE RADIATION INTENSITY AND PHOTON ENERGY SPECTRUM FOR A ^{170}Tm SOURCE. Maeda, Sho; Kondo, Shinsuke (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 17p. (In Japanese). NTIS (U. S. Sales Only).

The radiation intensity and the photon energy spectrum of a $^{170}Tm_2O_3$ source for radiography were calculated theoretically. For the $^{170}Tm_2O_3$ source of $3^{mm}\phi \times 3^{mm}$, 8.3 in density, the proportion of bremsstrahlung to the total radiation was 0.78 in radiation intensity, and the output radiation intensity was 0.0025 in Rhm value. (auth) (Japan)

Shielding Calculations and Theory

Refer also to abstracts 40385 and 40390.

40084 (EUR-4742) NEUTRON PROPAGATION IN WATER-LEAD-IRON LAMINATION. Chinaglia, B.; Bosio, G.; Vallana, F. (Ansaldo S.p.A., Genoa (Italy)); Monti, D. (FIAT, Turin (Italy). Sezione Energia Nucleare). 24 Jan 1972. 64p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 85.-.

Neutron propagation in lead/iron/water lamination of various thicknesses was accurately investigated by measurements of reaction rates of fast, epithermal and thermal detectors. A comparison was made with SABINE and QAD calculations in order to test their accuracy in dose evaluations. On the basis of experimental results new approaches to the problem of neutron behavior in shields are developed, i.e., (1) the relations between the ratios of reaction rates of the detectors measured respectively in the configurations and in pure water, and (2) methods for calculating neutron spectrum and dose starting from the above ratios and from the knowledge of a reference spectrum. (auth)

40085 (ORNL-TM-3785) VALIDITY OF USING ONLY PRIMARY PROTONS IN VAN ALLEN BELT AND SOLAR-FLARE PROTON SHIELDING STUDIES. Santoro, R. T.; Alsmiller, R. G. Jr.; Barish, J. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 15p. Dep. NTIS.

The validity of the approximations of neglecting proton attenuation due to nuclear collisions and all reaction products from nuclear collisions in space-vehicle shielding studies is tested. Comparisons of absorbed-dose and dose-equivalent results obtained with the production and transport of nuclear-reaction products included with similar results obtained using the approximations are presented. The use of the approximations is found to lead to a slight overestimation of the absorbed dose and dose equivalent for a wide range of incident Van Allen belt and solar-flare proton spectra and for a variety of shield thicknesses and shield materials. (auth)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 38126, 38987, 39459, 40059, and 40073.

40086 (CONF-720609–1) DISPLACEMENT FIELD AND IMAGE CONTRAST OF DISLOCATION LOOPS IN GRAPHITE. Ohr, S. M.; Noggle, T. S. (Oak Ridge National Lab., Tenn.). [1971]. 3p. Dep. NTIS.

From International carbon conference; Baden-Baden, Germany (26 Jun 1972).

The displacement fields around prismatic and shear dislocation loops in a hexagonal crystal were derived using anisotropic elasticity theory. In graphite, the magnitudes of the displacements parallel to the basal plane are about an order of magnitude smaller than expected from isotropic theory. Electron microscope contrast calculations were made and give good agreement with the experimental contrast for interstitial-type prismatic dislocation loops. (auth)

40087 (COO–1198-900) ANOMALOUS X-RAY TRANSMISSION CHANGES IN COPPER CRYSTALS ON ELECTRON IRRADIATION AT 14 K. Brown, Bruce Stilwell (Illinois Univ., Urbana). Jun 1972. Contract AT(11-1)-1198. 65p. Dep. NTIS. Thesis.

Anomalous x-ray transmission measurements were made at 4.2°K on nearly perfect crystals before and after irradiation at 14°K with 3-MeV electrons. Simultaneous resistance measurements were taken on high-purity copper wires. The measured intensity changes for (111), (222), (333), (220), (200), and (400) reflecting planes were investigated at intervals during the irradiation. Annealing studies at 22, 37, 78, and 295°K show x-ray intensity recoveries similar to resistance recoveries. Resistance increases show a linear dependence with electron fluence, while transmitted x-ray intensity decreases show a greater than linear dependence. Resistance changes with dose were comparable with previous data. X-ray-intensity decreases appear to be greater than predicted for the estimated concentration of point defects. A second irradiation of the transmission specimen after a long room-temperature anneal led to decreases in transmitted intensity that were about twice the changes seen after a similar electron fluence in the first irradiation. (auth)

40088 (UCRL–51209) X-RAY INDUCED PHOTOCONDUCTIVITY IN DIELECTRIC FILMS. Weingart, R. C.; Barlett, R. H.; Lee, R. S.; Hofer, W. (California Univ., Livermore. Lawrence Livermore Lab.). 27 Apr 1972. Contract W-7405-Eng-48. 32p. Dep. NTIS.

Measurements were made of the conductivity induced in films of polyethylene, epoxy, polytetrafluoroethylene, polyethylene terephthalate, polyimide, and glass by x rays at dose rates between 10^8 and 10^{10} rads/sec (dose in air). The films were 0.05- to 1.25-mm thick. The x-ray spectrum peaked in the vicinity of 10 keV, and the x-ray pulse width was about 40 nsec FWHM. X-ray-induced photocurrents were found to obey Ohm's law at low bias voltages (less than 1 kV). Above 1 kV, however, the peak photoconductivity signals from some of the 0.05-mm-thick materials began to increase at a slightly faster than linear rate with bias voltage. The glass samples exhibited no apparent delayed conductivity, while the other sample materials showed various amounts. The magnitude of the delayed conductivity in polytetrafluoroethylene, polyethylene terephthalate, and polyimide depended on the electric field, an effect that is consistent with Poole–Frenkel field-assisted carrier generation. The magnitude and time dependence of the conductivity signals were qualitatively described by a simple trapping model using reasonable values for mobility, trap density, capture cross sections, and trap depths. (auth)

40089 LATTICE THERMAL CONDUCTIVITY OF A NEUTRON-IRRADIATED COPPER–ALUMINUM ALLOY. Friedman, A. J.; Chu, T. K.; Klemens, P. G.; Reynolds, C. A. (Univ. of Connecticut, Storrs). Phys. Rev., B; 6: No. 2, 356-63(15 Jul 1972).

Low-temperature thermal-conductivity results are presented on two Cu–9-at.% Al polycrystals which show that fast-neutron irradiation has two effects on a cold-worked sample of this alloy. In the well-annealed specimen, irradiation produced defects which scatter long-wavelength phonons, giving a well-defined T^{-2} contribution to the lattice thermal resistivity. Observations by other authors using electron microscopy suggest that the defects are planar-vacancy-generated dislocation loops 75 to 100 Å in diameter. The loop density is calculated from the thermal resistivity and is found to be in reasonable agreement with the electron-microscopy results. In the second sample, deformed in tension at room temperature and then annealed at 573°K prior to irradiation, the same irradiation treatment produced a contribution to the lattice resistivity which was similar in temperature dependence but larger, by a factor of 3, than that produced in the well-annealed specimen. A model for this effect is suggested, based on two distinct contributions to the radiation-produced thermal resistivity: (i) dislocation loops of similar size and concentration as in the well-annealed sample; (ii) reformation of solute atmospheres around dislocations. These atmospheres had been thermally dispersed by annealing; their reformation is due to enhanced solute diffusion resulting from a large vacancy concentration produced by irradiation. The work of Mitchell et al. has shown that solute atmospheres in Cu–10 at.% Al enhances phonon scattering by dislocations. (auth)

40090 INTENSITIES OF LOW-ENERGY-ELECTRON-DIFFRACTION BEAMS FROM Be(0001). Jona, F. (State Univ. of New York, Stony Brook); Strozier, J. A. Jr.; Kumar, J.; Jones, R. O. Phys. Rev., B; 6: No. 2, 407-16(15 Jul 1972).

The intensities of several low-energy-electron-diffraction (LEED) beams from a clean Be(0001) surface are measured as functions of incident-electron energy, azimuth, and angle of incidence. The resulting LEED spectra (intensities vs energy) of the specular and of two nonspecular beams are plotted for two different azimuth angles from 20 to 300 eV and every 2° in incident angle from 0 to 24°. Several of the nonspecular spectra are compared with the results of calculations done by means of a band-matching perturbation approach utilizing a suitable pseudopotential. The comparison shows encouraging agreement considering, in particular, the speed and simplicity of the computations. Attention is drawn to the fact that the intensities of nonspecular beams from the basal plane of the hcp lattice depend on the way in which the structure is terminated at the surface, in contrast to the close-packed {111} face of the fcc lattice, for which termination plays no role. (auth)

40091 YIELD OF COLOR CENTER FORMATION IN KBr DOPED WITH KI. Hirai, Masamitsu (Atomic Energy Research Establishment, Harwell, Eng.). Solid State Commun.; 10: No. 6, 493-5(15 Mar 1972).

Measurements were made of F and H center production rates in KBr doped with KI, when electron irradiated at 5°K. Significant concentrations of I^- reduce the production rates of both centers. In the mixed crystals, complex H bands are formed and the thermal annealing behavior of these bands was measured. (auth)

40092 V CENTERS IN KBr. Treacy, D. J. (Naval Academy, Annapolis, Md.); Royce, B. S. H. J. Phys. Chem. Solids; 33: No. 4, 853-8(Apr 1972).

One of the major products of radiation damage in the range 120°K < T < 200°K is the D_3 center. Many effects previously associated with the V_4 center are more properly due to the D_3 center in conjunction with a center peaking at 280 nm. All results observed are consistent with the model of the D_3 center proposed by Itoh and Ikeya (J. Phys. Soc. Japan 22: 1172(1967)), an X_3^{-2} trihalide molecule ion oriented in a ⟨100⟩ direction. (auth)

40093 ELUCIDATION OF THE DAMAGE MECHANISM OF SYNTHETIC SODALITES BY ESCA. Brinen, J. S. (American Cyanamid Co., Stamford, Conn.); Wilson, L. A. J. Chem. Phys.; 56: No. 12, 6256-7(15 Jun 1972).

The surface chemistry of sodalites before and after exposure to 2-keV electrons and after thermal bleaching was studied by electron spectroscopy for chemical analysis (ESCA). The results demonstrate that the permanent (not bleachable by light) coloration produced by electron bombardment is associated with a substantial decrease of surface halogen and sodium. It is suggested that sodium and halogen ion vacancies created on the surface by the impinging electrons diffuse into the crystal, and that bleaching by heat restores the chemical balance of the surface. (A.G.W.)

40094 STIMULATED EXOELECTRON EMISSION FROM THE SURFACE OF INSULATING SOLIDS. Becker, Klaus (Oak Ridge National Lab., Tenn.). CRC Crit. Rev. Solid State Sci.; 3: No. 1, 39-81(Mar 1972).

An extensive review is presented of exoelectron phenomena and the Kramer effect. Both optically stimulated and thermally stimulated exoelectron emission are considered. The emission mechanism is discussed. Materials whose studies are reviewed include alkali metal halides, alkaline earth halides, sulfates, sulfides, metal oxides, and complex compounds. Factors affecting exoelectron emission are listed (particle size, heating, irradiation, impurities, etc.). Instrumentation for exoelectron studies is surveyed, and applications of exoelectron emission (radiation dosimetry) are reviewed. (60 figures, 286 references) (D.L.C.)

40095 DEFECTS IN LOW-TEMPERATURE IRRADIATED SINGLE CRYSTALS OF $NaClO_3$: ClO_3 CENTERS. Vinther, O. (Univ. of Aarhus, Denmark). J. Chem. Phys.; 57: No. 1, 183-7(1 Jul 1972).

Defects generated in single crystals of $NaClO_3$ by x irradiation at −247 and −196°C were studied using ESR and uv spectroscopy. The defects are assigned to: ClO_3, ClO_2, and O^{2-}. ClO_3 is formed in two modifications with different g and A tensors, optical absorption, and thermal stability at −196°C. One modification can be transformed into the other by illumination with light of wavelengths longer than 5500 Å. A mechanism for the light-induced decay of ClO_3 involving electron transfer from O^{2-} to ClO_3 is proposed. Comparison is made between ClO_3 formed in $NaClO_3$ and in irradiated perchlorates. (auth)

40096 EFFECT OF SIMULATED SPACE RADIATION ON SELECTED OPTICAL MATERIALS. Nicoletta, C. A.; Eubanks, A. G. (Goddard Space Flight Center, Greenbelt, Md.). Appl. Opt.; 11: No. 6, 1365-70(Jun 1972).

The effect of simulated Nimbus spacecraft orbital (1100 km, circular, and polar) radiation on wide-bandpass glass filters, narrow-bandpass thin-film interference filters, and several fused silicas was determined by transmittance measurements over the 200 to 3400-nm wavelength region. No changes were observed in the filters, which were shielded with fused silica during irradiation, after exposure to a 1-yr equivalent orbital dose of electrons, nor were changes observed in the fused silicas after the same electron exposure plus a 1-yr equivalent dose of protons. Exposure to a ½-yr equivalent dose of solar uv radiation, however, caused a significant degradation in the transmittance of two uv-transmitting interference filters but had no effect on two colored glass filters that transmitted in the visible and near-ir regions. As a result of the uv exposure, the fused silicas exhibited losses of several percent over the 200 to 300-nm wavelength region. (auth)

40097 ANOTHER MEASUREMENT OF THE POLARIZATION OF DEUTERONS CHANNELED THROUGH THIN Ni FOILS. Feldman, L. C. (Bell Telephone Labs , Murray Hill, N. J.); Mingay, D. W.; Sellschop, J. P. F. Radiat. Eff.; 13: No. 3-4, 145-51(Apr 1972).

A measurement of the tensor polarization of deuterons channeled through a magnetized Ni single crystal and emerge as deuterium atoms is described. The results are in qualitative agreement with the surprisingly large polarization first observed by Kaminsky (Phys. Rev. Lett.; 23: 819(1969)). Experimental details and various control experiments are discussed. (auth)

40098 INFLUENCE OF CHANNELING AND ANOMALOUS DIFFUSION ON THE PROFILES OF IMPLANTED PHOSPHORUS AND BORON ATOMS IN SILICON. Pavlov, P. V.; Zorin, E. I.; Tetel'baum, D. L.; Baranova, A. S.; Vasil'ev, V. K. (Gorky State Univ., USSR). Radiat. Eff.; 13: No. 3-4, 153-5(Apr 1972).

Distribution of charge carriers in silicon implanted with boron and phosphorus at room temperature and annealed at $T_{ann} \approx 800°C$, have rather long tails. The possible mechanisms for their formation are channeling and different kinds of anomalous diffusion. The contribution of these factors was investigated. (auth)

40099 LINDHARD'S MULTIPLE SCATTERING DESCRIPTION JUSTIFIES AXIAL AND PLANAR DECHANNELLING DATA. Campisano, S. U.; Foti, G.; Grasso, F.; Lo Savio, M.; Rimini, E. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Radiat. Eff.; 13: No. 3-4, 157-66(Apr 1972).

The dechannelled fraction vs. penetration depths $\chi(z)$ was measured for 0.3- to 1.5-MeV protons impinging along the $\{110\}$ plane of Si and Ge. The experimental results show an exponential trend of $\chi(z)$ vs. the penetration depth and a very small dependence on the crystal temperature. The theoretical model previously proposed to describe the axial dechannelling in terms of changes in the ion transverse energy was extended to the planar case. Due to the difference in symmetries between planes and axes, the change of transverse energy gives rise to a diffusion equation. The analytical form of the diffusion coefficient was obtained taking into account the Lindhard's (1965) description of nuclear and electronic reduced multiple scatterings. A comparison between the planar and the axial case brings into light the different role played by nuclear and electronic scatterings in dechannelling. (auth)

40100 COMPARISON OF SECONDARY ION YIELDS FROM CONDUCTING, SEMICONDUCTING, AND NONCONDUCTING TARGETS BOMBARDED WITH 40 keV ARGON IONS. Jurela, Z. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Radiat. Eff.; 13: No. 3-4, 167-70(Apr 1972).

Conducting, semiconducting, and nonconducting targets were bombarded at an angle of 45° to the surface with a beam of Ar^+ ions, characterized by a beam density of $100\ \mu A/cm^2$ and a beam energy of 40 keV. The residual gas pressure was 5×10^{-6} torr. The ion yield or the degree of ionization of sputtered atoms from the three kinds of targets were measured. The results indicate that the emission of secondary ions from the three types of bombarded surfaces can be described using the same model. The degree of ionization and the energy distribution of the sputtered target atoms confirm that the emission is a combination of two mechanisms: momentum transfer by the primary ions to target atoms, and strong local overheating of sputtered centers. The yield of various secondary ion species from compound targets is not proportional to the concentration of the respective atoms in the targets. (auth)

40101 ORIENTATION DEPENDENCE OF INTENSITY AND ENERGY LOSS OF HYPERCHANNELED IONS. Appleton, B. R.; Barrett, J. H.; Noggle, T. S.; Moak, C. D. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 13: No. 3-4, 171-81(Apr 1972).

Energy loss measurements are reported for 21.6- to 60-MeV ^{127}I and 3-MeV ^4He ions transmitted through thin single crystals of Au and Ag along directions parallel or nearly parallel to $\langle 110 \rangle$ directions in the crystals. A systematic investigation of 21.6-MeV ^{127}I ions in Ag indicates that for incidence angles within 0.12° of [011] up to 10% of the transmitted ions have energy losses significantly lower than that for ions transmitted parallel to $(1\bar{1}1)$. The behavior of these ions is consistent with that expected for ions which are confined within one particular axial channel throughout the crystal. This specific type of axial channelling is termed hyperchanneling. The data for hyperchanneled 21.6-MeV ^{127}I in Ag are analyzed in detail and discussed in terms of a theory developed on the basis of potential energy contours obtained from the continuum potentials of the surrounding rows of atoms. Comparison of theory and experiment suggests that these ions undergo more multiple scattering than can be accounted for and that potentials for interactions of ions and free atoms are not entirely adequate for interactions of ions and atoms in a solid. (auth)

40102 CORRELATED ATOMIC COLLISION SEQUENCES AT SOLID SURFACES. Mashkova, E. S.; Molchanov, V. A. (Moscow State Univ.). Radiat. Eff.; 13: No. 3-4, 183-90(Apr 1972).

An experiment was performed to investigate several effects caused by correlated successive collisions of fast ions at crystalline surfaces. Predictions of simple models for ion scattering processes are examined qualitatively, and the obtained experimental data are discussed in the framework of these models. As targets, faces of copper, silicon and germanium single crystals were used. The bombarding ions were 5 to 30 keV argon ones. (auth)

40103 STOPPING POWERS OF C, N, AND O IONS IN Cr, Fe, Co, Ni, Cu, AND Zn IN THE 1 MeV REGION. Bjoerkqvist, K ; Domeij, B. (Research Inst. for Physics, Stockholm). Radiat. Eff.; 13: No. 3-4, 191-6(Apr 1972).

The stopping powers of C, N, and O ions in Cr, Fe, Co, Ni, Cu and Zn in the energy range 500 keV to 2 MeV were measured relative to that for He ions in the same material. The measurements were made utilizing energy spectra of particles backscattered from thick substrates of the target material into which a heavy material (Bi) had been previously implanted to a shallow depth. Assuming that dE/dx for He is known, the dose of implanted Bi can be determined from a He backscattering spectrum. Then this dose is used to calculate the unknown stopping power from a backscattering spectrum of the ion to be studied. The data are analyzed in terms of a function $(dE/dx) = aE^p + b$. The experimental results give values of p ranging from 0.3 to 0.5. The absolute dE/dx values (normalized to known dE/dx values for He ions) are somewhat higher than those tabulated by Northcliffe and Schilling (1970) and considerably higher than predicted by the LSS theory. (auth)

40104 NON-EVIDENCE FOR Z_1 OSCILLATIONS OF THE NUCLEAR ION–ATOM INTERACTION IN AN AMORPHOUS TARGET. Hoegberg, G.; Skoog, R. (Chalmers Univ. of Tech., Goteborg). Radiat. Eff.; 13: No. 3-4, 197-202(Apr 1972).

Periodic variations in the Z_1 dependence of the interatomic potential was recently revealed by a channeling technique. To search for oscillations of similar kind in a target of randomly arranged atoms systematic measurements were made on the scattering distributions of energetic (32 to 56 keV) ions in amorphous carbon. The technique was to transmit light mass ions through carbon foils with a thickness of 2 to 4 $\mu g/cm^2$. The atomic number of the ions, Z_1, ranged from 3 to 18. The scattering distribution of the transmitted particles was recorded. From these curves the angular halfwidth, $\psi_{1/2}$, and the relative intensity at a scattering angle 2.5

times ψ_c was determined. The experimental values are in good agreement with theoretical calculations based on the Thomas–Fermi and Lenz–Jensen potentials. Furthermore, the saturation value of the mean nuclear stopping cross sections for ions scattered in the straight forward direction with a mean energy of 50 keV are given. No evidence for a Z_1 oscillatory behavior could be found in any of the three parameters investigated. (auth)

40105 MULTIPLE SCATTERING OF HEAVY IONS OF keV ENERGIES TRANSMITTED THROUGH THIN, POLYCRYSTALLINE GOLD FOILS. Andersen, H. H.; Boettiger, J.; Knudsen, H. (Univ. of Aarhus, Denmark). Radiat. Eff.; 13: No. 3-4, 203-7(Apr 1972).

Experimental studies are described of the multiple scattering of 14 different heavy ions with $1 \leq Z_1 \leq 18$ in the energy range 300 to 1000 keV, transmitted through thin (500 Å to 1500 Å) polycrystalline gold films. The experimental data are compared with calculations of the multiple scattering using the Thomas–Fermi potential. Rather large deviations from theoretical predictions are found, in contrast to the case for lighter targets. (auth)

40106 ANISOTROPIC K_α X-RAY PRODUCTION BY 350 keV ELECTRONS IN GERMANIUM SINGLE CRYSTALS. Bronder, Th.; Jakschik, J. (Physikalisch-Technische Bundesanstalt, Berlin). Radiat. Eff.; 13: No. 3-4, 209-13(Apr 1972).

Bombarding thin single-crystal films with electrons an increase of K x-ray yield is observed if a crystallographic axis or plane is rotated into the beam direction. In the case of epitaxial foils the shape of the yield peaks is of Gaussian type and the width is larger than twice the Bragg angle, depending strongly on target preparation. These peaks were investigated around the [111] axis of a germanium single crystal thinned by ion-sputtering to a thickness of about 1 μm. An exact agreement of the width with twice the Bragg-angle and a fine structure related to the Kikuchi pattern was observed. (auth)

40107 HEAVY-ION RANGE PROFILES AND ASSOCIATED DAMAGE DISTRIBUTIONS. Winterbon, K. B. (Univ. of Aarus, Denmark). Radiat. Eff.; 13: No. 3-4, 215-26(Apr 1972).

Detailed distributions of the ranges of heavy ions in amorphous targets and of the associated radiation damage were obtained for low (keV) incident-ion energies, neglecting electronic stopping. Moments of the distributions (mean depth, straggling, and so on) and some distributions were also computed with electronic stopping taken into account for dimensionless energies ϵ up to ~10 to 100. These calculations are exact within the LSS theory; in particular, nuclear and electronic stopping are separated, the target is amorphous and infinite, collisions are binary, and electronic stopping is included as a continuous retardation, proportional to the velocity of the moving ion. Results were obtained for various ratios of projectile and target mass, and for some compound targets. Interpretation of the results is discussed, and possible experimental verifications suggested. (auth)

40108 INTERACTION OF INJECTED HELIUM WITH LATTICE DEFECTS IN A TUNGSTEN CRYSTAL. Kornelsen, E. V. (National Research Council of Canada, Ottawa). Radiat. Eff.; 13: No. 3-4, 227-36(Apr 1972).

Helium injected into tungsten was found to undergo rapid interstitial diffusion at room temperature unless it encountered lattice defects. This effect was used in a study of the lattice damage produced near a (100) tungsten surface by the impact of small numbers of 5-keV heavy ions. The helium, injected as 250-eV ions, does not itself produce any observable damage, but is trapped in that created by the prior heavy ion bombardment. Thermal desorption spectra obtained by raising the crystal temperature at 40°K/sec show that the helium is bound with several discrete energies. Attempts to correlate the binding states with particular lattice defects were made by varying the damage anneal temperature, the helium dose, the helium injection temperature and the mass of the damaging ion. The results suggest that all of the entrapment occurs at defects of the vacancy type, and that the binding energy is modified by parameters that change the available vacancy volume. In particular, there is evidence that at least two and possibly three helium atoms can be trapped in a single vacancy, that two types of divacancies exist, and that vacancies become trapped in the strain field of large impurity atoms. It also appears that at sufficiently high helium doses ($>10^{14}$ ions/cm^2), any of the trapping sites can act as nuclei for the formation of helium bubbles. (auth)

40109 COMPUTER STUDIES OF BORON ION CHANNELING IN SILICON SINGLE CRYSTALS. Eltekov, V. A.; Karpuzov, D. S.; Martynenko, Yu. V.; (and others) (Moscow State Univ.). Radiat. Eff.; 13: No. 3-4, 237-42(Apr 1972).

The motion of 200-keV B ions in the [111] direction in a silicon single crystal was investigated using computer-simulation method. Profiles of the depth distribution of implanted ions for both an ideal crystal and a crystal with thermal vibrations were obtained. A study of the defect distribution was carried out. (UK)

40110 ENERGY SPECTRA OF SPUTTERED IONS. Dennis, E.; MacDonald, R. J. (Australian National Univ., Canberra). Radiat. Eff.; 13: No. 3-4, 243-8(Apr 1972).

The energy spectrum of Cu$^+$ ions sputtered from Cu single crystals was studied using a retarding-potential energy-selector method that incorporates a quadrupole mass filter as detector. The behavior of the energy spectrum of Cu$^+$ in the region of the ⟨110⟩, ⟨100⟩ focused ejection spots was studied in detail and the results compared with those of Thompson (Phil. Mag.; 18: 377(1968)) who measured the energy spectrum of neutral Cu atoms sputtered along these directions. The Cu$^+$ energy spectra show evidence for the existence of focusing mechanisms and the focusing energies of (55 ± 2) eV and (150 + 10) eV, respectively, agree well with Thompson's results for the neutrals. (auth)

40111 MULTIPLE SCATTERING OF VARIOUS IONS IN CARBON AND GERMANIUM. Bernhard, F.; Krygel, P.; Manns, R.; Schwabe, S. (Humboldt-Univ., Berlin). Radiat. Eff ; 13: No. 3-4, 249-55(Apr 1972).

Some new experimental results are reported on multiple scattering of H, He, Li, Ne, Ar, and Kr ions in the energy range between 100 and 1000 keV. The scattering foils of carbon and germanium, with thicknesses between 300 and 1100 Å, were self-supporting. The results of the scattering measurements were compared with the theories of Meyer (Phys. Stat. Sol. (b); 44: 253(1971)) and Molière (Z. f. Naturforschg. 3a, 78(1948)), respectively. Absolute deviations from the theory are always less than 20% for the half-widths. A substantially better correspondence between theory and experiment is achieved by fitting the screening parameter of the interaction potential. (auth)

40112 EFFECT OF SULPHUR DISPLACEMENT ON THE CATHODOLUMINESCENCE OF ZINC SULPHIDE. Bryant, F. J.; Manning, P. S. (Univ. of Hull, Eng.). Radiat. Eff.; 13: No. 3-4, 267-9(Apr 1972).

Irradiation with electrons of energy sufficient to displace sulphur atoms (i.e. greater than ~190 keV) but insufficient to produce zinc displacements (i.e. <235 keV) results in the production of an emission peak at 0.83 μm in the infrared cathodoluminescence spectrum of zinc sulphide. Enhancement of the 0.83 μm emission band could be produced by electron damage at liquid helium, liquid nitrogen or room temperatures. (auth)

40113 PROTON DECHANNELING IN ALKALI HALIDE MIXED CRYSTALS. Miyagawa, Soji; Morita, Kenji; Matsunami, Noriaki; Tachibana, Kazuya; Itoh, Noriaki (Nagoya Univ., Japan). Radiat. Eff.; 13: No. 3-4, 271-6(Apr 1972).

The effects of the lattice distortion in KCl–KBr mixed crystals on the dechanneling of 1.5-MeV protons are studied by means of backscattering. The dechanneling rate vs. the composition curve has a maximum at about 1 : 1 mixture of KCl and KBr. The lattice distortion in the mixed crystals is estimated from the dechanneling rate, and the result agrees well with that obtained by an x-ray measurement. The effective cross section for the dechanneling caused by the lattice distortion is obtained, and compared with the results of a calculation based on a simple model. (auth)

40114 POSITRON CAPTURE BY COLOR CENTERS IN SINGLE CRYSTALS. Aref'ev, K. P.; Vorob'ev, S. A. (Tomsk Polytechnical Inst., USSR). Phys. Lett.; 39A: No. 5, 381-2 (5 Jun 1972).

The effect of KCl single crystal tempering on the annihilation quanta angular correlation was investigated. The narrow component of the correlation curves in the samples colored by electron-beam irradiation was revealed. The heat treatment of the colored crystals increases the narrow component intensity. (auth)

40115 VARIATIONS OF ENERGY SPECTRA OF BACKSCATTERED PROTONS FROM Si SINGLE CRYSTALS. Sone, K.; Fukuzawa, F. (Kyoto Univ.). Phys. Lett.; 40A: No. 1, 11-12 (19 Jun 1972).

Backscattering energy spectra in channeling experiments vary with the angle of incidence with respect to a channeling direction and have high-energy humps at slightly larger angles than the critical angle for channeling. (auth)

40116 CHANNELING IN Si OVERLAID WITH Al AND Au FILMS. Rimini, E.; Lugujjo, E.; Mayer, J. W. (California Inst. of Tech., Pasadena). Phys. Rev., B; 6: No. 3, 718-28(1 Aug 1972).

Channeling measurements by backscattering of 1.8-MeV He ions were made on ⟨111⟩- and ⟨110⟩-oriented Si covered with evaporated layers of Al and Au. The minimum yield, half-width of the angular-yield profile, and depth dependence of the aligned yield were measured as a function of metal-film thickness. Comparisons between experimental and calculated values were made on the basis of two different treatments of plural scattering. The minimum yield follows the predictions of the Meyer treatment.

This treatment leads to good agreement with angular-yield profiles and dechanneling dependence on depth obtained with Al films. For Au films, the measurements suggest that the distribution should be more peaked than that calculated. These results can also be applied to investigations of dechanneling and disorder in single crystals. (auth)

40117 METHOD FOR PRODUCING SEMICONDUCTOR DEVICE UTILIZING ION IMPLANTATION. Tsuchimoto, Takashi; Tokuyama, Takashi; Komatsubara, Kiichi (to Hitachi, Ltd.). U. S. Patent 3,660,171. 2 May 1972. Priority date 27 Dec 1968, Japan.

A method is given for producing a transistor structure. The method comprises the steps of implanting ions of base-forming impurity into a predetermined portion of a surface of a semiconductor body serving as a collector and heated to a temperature above 600°C but below the melting point of the semiconductor to form a base region, and thereafter implanting ions of emitter-forming impurity into a predetermined portion of the surface of said base region heated to a temperature in the range of 400° to 600°C to form an emitter region. (AEC)

40118 CHANNELING PATTERNS RECORDED USING RADIOACTIVE RECOIL ATOMS. Jech, C. (Inst. of Physical Chemistry, Prague). Phys. Lett.; 39A: No. 5, 417-18(5 Jun 1972).

Differences in the penetration of ^{220}Rn recoil atoms injected from a ^{224}Ra point source into single crystals of Si, SiO_2, and KCl were used to record patterns showing directions and planes along which the recoil atoms channeled deeper into the crystal. (auth)

40119 EVIDENCE OF AN ATOMIC DISPLACEMENT PROCESS IN ELECTRON-IRRADIATED α-TIN. Myhra, S.; Gardiner, R. B. (Univ. of Queensland, Brisbane). Phys. Lett.; 39A: No. 5, 405-6(5 Jun 1972).

The dc resistance of semiconducting α-tin is found to be strongly dependent on the dose and energy of electron irradiation. A threshold displacement energy of about 12 eV is obtained. The annealing spectrum shows three distinct low-temperature stages. (auth)

40120 PHOTOELECTRIC EFFECT IN LOW-RESISTIVITY CdTe CRYSTALS IRRADIATED WITH ^{60}Co γ RAYS. Dmitriev, G. D.; Karpenko, V. P.; Kashershininov, P. G.; Matveev, O. A. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 11, 1898-9(May 1972).

Translated from Fiz. Tekh. Poluprov.; 5: No. 11, 2185-7 (Nov 1971).

An investigation was made of the capacitance characteristics of surface-barrier junctions in n-type CdTe crystals with an electron density of 10^{14} cm^{-3}. The crystals were illuminated with light (0.5 to 2.0 eV) and irradiated with γ rays at 77°K. The photomemory (change in capacitance which is retained after illumination) falls with increasing energy in the fundamental absorption edge region. The memory after the end of the γ irradiation exceeds the photomemory. The parameters of the deep levels were determined; the hole-capture cross section has a strong temperature dependence, with the energy of the excited level being ~0.04 eV. (D.L.C.)

40121 INTERACTION OF LITHIUM WITH RADIATION DEFECTS IN PURE n-TYPE GERMANIUM. Sinishchuk, I. K.; Tkachev, V. D.; Urenev, V. I. (Belorussian State Univ., Minsk). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 11, 1910-11(May 1972).

Translated from Fiz. Tekh. Poluprov.; 5: No. 11, 2195-7 (Nov 1971).

Ge crystals doped with Sb and then Li were irradiated at 30°C with ^{60}Co γ-ray doses of 10^{16} to 7×10^{17} cm^{-2}. The temperature dependence of the Hall coefficient was measured before and after irradiation and annealing up to 450°C. A dose of 6.7×10^{17} cm^{-2} resulted in n–p conversion and a level at $E_v + 0.27$ eV. At lower doses, n-type conduction was retained with a level at $E_c - 0.20$ eV. Annealing at 120°C also resulted in n–p conversion with a level at $E_v + 0.30$ eV, and higher temperatures increased the hole density and produced a new acceptor defect at $E_v + 0.18$ eV, probably a Li–divacancy complex. The recovery of n-type conduction during annealing was studied. A model is proposed for the formation of Li–divacancy complex. (D.L.C.)

40122 FORMATION OF γ-RADIATION DEFECTS IN PHOSPHORUS-DOPED GERMANIUM. Abdullaev, A.; Emtsev, V. V.; Korchazhkina, R. L.; Mashovets, T. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 11, 1947-8(May 1972).

Translated from Fiz. Tekh. Poluprov.; 5: No. 11, 2229-31 (Nov 1971).

P-doped Ge was irradiated with ^{60}Co γ rays and the temperature dependence of the Hall coefficient analyzed for the dose dependence of the carrier density and the densities of the energy levels produced during irradiation. Features of the defect formation process are pointed out for the $E_c - 0.15$ eV (M_1), $E_c - 0.22$ eV (M_2), and $E_v + 0.12$ eV (M_3), after n–p conversion levels. The lower-half of the forbidden band also contains levels at $E_v + 0.010$ eV which are due to the group III acceptors. The kinetics of the defect generation confirms that the process responsible for the n–p conversion is reduction in the density of P donor levels, probably due to formation of P–vacancy (VP) complexes. The electron states of the VP complexes must lie in the valence band. It is not yet possible to determine the nature of the M_1 and M_2 levels, but the M_3 ($E_v + 0.12$ eV) levels are probably associated with P–divacancy complexes. (D.L.C.)

40123 RADIATION-DEFECT FORMATION IN GERMANIUM. Vitovskii, N. A.; Emtsev, V. V.; Kotina, I. M.; Mashovets, T. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 11, 1949-51(May 1972).

Translated from Fiz. Tekh. Poluprov.; 5: No. 11, 2231-3 (Nov 1971).

It is shown that the dose dependences of the densities of various levels in Ge doped with different group V elements do not generally follow a monotonic relationship. There are only two types of centers whose density increases monotonically with dose: the level, $E_v + 0.27$ eV, and the centers whose concentration increases practically from zero after the n–p conversion and reaches saturation. Various factors which may be responsible for the observed non-monotonic dependences are discussed briefly. The shift of the Fermi level is also considered. (D.L.C.)

40124 VOLTAGE-CURRENT CHARACTERISTICS OF THE DIODES PRODUCED BY THE METHOD OF IONS IMPLANTATION. Rosinski, Witold. Arch. Elektrotech. (Warsaw); 21: No. 1, 195-200(1972). (In Polish).

A possibility of punch-through due to the spreading of the space-charge region in the contact on the p side of the junction formed by implantation of boron atoms into silicon is considered. To check this, a Gaussian distribution of the boron atoms was assumed and the relation between the ionized impurities concentration and junction voltage for punch-through was evaluated. Results of calculations confirm the results of measurements. (auth)

40125 DIELECTRIC BREAKDOWN IN A DILUTE PLASMA. McKinzie, D. J. Jr.; Grier, N. T. (Lewis Research Center, Cleveland). J. Spacecraft Rockets; 9: No. 5, 381-3(May 1972).

Dielectrics for possible use in solar cell arrays were tested at bias voltages as high as 20 kV dc in an argon plasma with electron number densities of ~10^6 particles/cm^3. Data of breakdown voltages for specific thicknesses are presented. On the basis of these tests, Teflon FEP or possibly Teflon TFE specimens appear as most promising; Teflon TFE did not break down at 20 kV for the thicknesses tested, thus was excluded for comparison purposes in the test. (L.M.T.)

40126 NATURE AND MECHANISM OF SURFACE POLYGONIZATION OF NaCl AND KCl SINGLE CRYSTALS PRODUCED BY ELECTRON BOMBARDMENT AND ILLUMINATION. Teodorescu, I. A.; Arsenovici, L. C. (Inst. for Atomic Physics, Bucharest). Radiat. Eff.; 14: No. 1-2, 131-7(May 1972).

The polygonization phenomenon observed on alkali metal halide surfaces irradiated with electrons and subsequently illuminated was studied by optical and electron microscopy. For the explanation of the nature and mechanism of this process, the influence of light (containing the F-centre absorption band) on the development and annihilation in time of some polygonization lines was investigated, as well as the correlation of the polygonization patterns with dislocation etch pits and subgrain boundaries revealed by a selective chemical etching. Preceded by an optical bleaching effect which locally induces surface potential changes, the polygonization process is explained taking into account the mobility of unpinned charged dislocations and the surface atom migration. The disappearance of some polygonization lines may be produced by a vacancy–interstitial annihilation process. No identification was found between the polygonization patterns and the subgrain boundaries. (auth)

40127 PARAMAGNETIC CENTERS FORMED BY IRRADIATION IN POLYCRYSTALLINE AMMONIUM PARATUNGSTATE. Constantinescu, O.; Pascaru, I.; Constantinescu, M.; Arizan, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 1, 39-45(1972). (In French).

Polycrystalline $5(NH_4)_2O \cdot 12WO_3 \cdot 5H_2O$, γ-irradiated at 77°K and at room temperature, was studied by ESR. The ESR spectra suggested the formation of three paramagnetic species, which were assigned to radicals of the types NH_3^+, $(W_{12}O_{41})^{9-}$, and a species with W(V). A radiolytic scheme is proposed. (auth)

40128 ANNEALING OF DEFECTS PRODUCED BY ROOM-TEMPERATURE IRRADIATION IN KCl:Ca AND KCl:Sr CRYSTALS. II. Seretlo, J. R. (Univ. of Fort Hare, S. Afr.). Phys. Status Solidi (a); 11: No. 1, 319-25(16 May 1972).

Thermal annealing of defects produced by room-temperature (RT) x irradiation of KCl : Ca (133 ppM Ca^{2+}) and KCl : Sr (100 ppM Sr^{2+}) was investigated. It is found that the F centers anneal out along with centers responsible for the complex absorption band showing a peak at 220 nm, in a prominent stage occurring in the temperature range 298 to 440°K. It is concluded that the centers absorbing in the ultraviolet spectral region are interstitials. A model based on detrapping of interstitials at clusters or traps was developed to account for the annealing of these defects as well as vacancy centers in impurity-doped and "pure" KCl crystals. (auth)

40129 THERMOELECTRIC POWER OF SOME ALLOYS AFTER REACTOR IRRADIATION. Markina, N. V.; Raetskii, V. M.; Samsonov, B. V.; Tsykanov, V. A. Fiz. Metal. Metalloved.; 32: No. 6, 1316-18(Dec 1971). (In Russian).

Thermocouples of Chromel/Alumel and tungsten/rhenium were irradiated in a reactor at levels of 3×10^{12} thermal neutrons/$cm^2 \cdot s$ + 3.8×10^7 R/hr gamma + 3.9×10^{11} fast neutrons/$cm^2 \cdot s$, and later 6.2×10^{13} thermal neutrons/$cm^2 \cdot s$ + 5.4×10^8 R/hr gamma + 5.5×10^{12} fast neutrons/$cm^2 \cdot s$. The thermo emf of Chromel/Alumel increased with radiation dose, while that of W/Re decreased. Similar tests were run on Chromel/Pt and Pt/Alumel; the emf of these two pairs increased and decreased, respectively, with increasing intensity of irradiation. (K.S.W.)

40130 OSOBENNOSTI RADIATSIONNOGO POVREZHDENIYA POLUPROVODNIKOV CHASTITSAMI VYSOKIKH ENERGII. (Radiation Damage to Semiconductors by High-Energy Particles). Konopleva, R. F.; Litvinov, V. L.; Ukhin, N. A. Moscow; Atomizdat (1971). 76p.

The formation of structural damage in semiconductors by high-energy particles and the spatial distribution of defects are examined. Electron microscope studies of disordered regions in Ge, Si, and in types A^{III} and B^V semiconductors are described. The results of galvanomagnetic, electrical, recombination, optical, and heat-conductive studies suggest that the character of radiation damage is different from simple defects produced by γ radiation or by electrons of several MeV energy. Separate chapters are devoted to each of these investigative approaches. 215 references. (K.S.W.)

Physical Properties

Refer also to abstracts 38126, 38861, 38884, 38958–38962, and 38968.

40131 (BNL-tr-483) DEBYE–WALLER FACTOR FOR ALLOYS OF THE NIOBIUM–ZIRCONIUM SYSTEM. Korsunskii, M. I.; Genkin, Ya. E.; Vigdorchik, L. I. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 73-5(1971). 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 26: 10338.

40132 (IS-T-513) DETERMINATION OF THE FERMI SURFACE OF MOLYBDENUM USING THE DE HAAS–VAN ALPHEN EFFECT. Hoekstra, James Alvin (Ames Lab., Iowa). May 1972. Contract W-7405-eng-82. 99p. Dep. NTIS. Thesis.

The de Haas–van Alphen effect in molybdenum was studied in detail using large impulsive magnetic fields. Digital data recording, fast-Fourier frequency analysis by computer, and dynamic calibration of the entire apparatus was used to obtain the de Hass–van Alphen frequencies to a high degree of accuracy. Several new frequency branches associated with the electron jack piece of the Fermi surface are reported. Frequency branches exhibiting high angular accuracy and resolution are reported for all branches that have previously been detected by other de Hass–van Alphen investigators. A quantitative description of all sheets of the Fermi surface is presented, along with comparisons with other Fermi surface radii obtained by use of the radiofrequency size effect (RFSE). The Mueller inversion technique for obtaining Fermi-surface radii from the de Hass–van Alphen area data was used whenever possible. The de Haas–van Alphen results presented are consistent with an estimate of 2.5% of the ΓH dimension for the size of the gap between the jack and the octahedral Fermi surface pieces. Thus, the question about the size of this gap as raised by discrepancies greater than the combined experimental errors existing in current RFSE data is resolved. The spin–orbit parameter is not found to be anomalously higher than that for tungsten. (auth)

40133 HALL EFFECT IN ERBIUM MONOCRYSTALS. Fedorov, G. V.; Morozova, V. A.; Moreva, N. I.; Volkenshtein, N. V. (Inst. of Metal Physics, Giredmet, USSR). Fiz. Metal. Metalloved.; 32: No. 6, 1226-30(Dec 1971). (In Russian).

Hall effect measurements were conducted on two samples that had been machined out of a monocrystal of erbium. The measurements were made over the temperature range 4.2 to 310°K and up to 23 kG. The magnetic field was parallel to the [0001] axis in one sample, and to the [1210] axis in the other. Anisotropy of the Hall coefficients R_0 and R_s was detected in the paramagnetic state. Anisotropy of the field and temperature dependence of the specific Hall emf was observed in the region of magnetically ordered structures. (tr-auth)

40134 EFFECT OF PLASTIC DEFORMATION ON THE PARAMAGNETIC SUSCEPTIBILITY OF MOLYBDENUM MONOCRYSTALS. Deryagin, A. I.; Pavlov, V. A.; Vlasov, K. B.; Grubova, S. P. (Inst. of Metal Physics, Giredmet, USSR). Fiz. Metal. Metalloved.; 32: No. 6, 1231-6(Dec 1971). (In Russian).

The paramagnetic susceptibility of Mo monocrystals was studied at room temperature as a function of their plastic deformation. With an increase in the degree of the latter an increase in the susceptibility was observed, and a development of a nonlinear dependence of susceptibility on the magnetic field strength was noted up to 1000 Oe. (tr-auth)

40135 SPIN ECHO STUDY OF ZIRCONIUM–HYDROGEN COMPOUNDS. Khodosov, E. F.; Shepilov, N. A.; Savin, V. I. (Donets Physical-Technical Inst., USSR). Fiz. Metal. Metalloved.; 32: No. 6, 1313-15(Dec 1971). (In Russian).

The Zr–H system was studied by the spin-echo method, using a frequency of about 21 MHz. From the data the energy of activation and the Arrhenius value A_0 were calculated for the self-diffusion of hydrogen over a range of temperatures. (K.S.W.)

40136 PSEUDOPOTENTIAL CALCULATION OF BINDING ENERGIES, STRUCTURES, AND LATTICE CONSTANTS OF SIMPLE METALS. Hafner, J.; Nowotny, H. (Technische Hochschule, Vienna). Phys. Status Solidi (b); 51: No. 1, 107-14(1 May 1972).

The nonlocal pseudopotential formalism of Harrison is applied to the problem of binding energies, structures, and lattice constants of nine simple metals (Li, Be, Na, Mg, Al, K, Ca, Zn, and Ga). The formulation of the crystal potential is similar to that given by Harrison, but the Kohn–Sham approximation is used for the description of the core–valence exchange interaction, and the effect of the orthogonalization hole on the core energies is computed by a weighted-average scheme. Exchange and correlation between the conduction electrons are taken into account using the modified dielectric function proposed by Kleinman and Langreth. The correct structure is predicted in all cases and the binding energies, equilibrium atomic radii, and axial ratios are obtained with good accuracy. (auth)

40137 OPTICAL ANISOTROPY OF β-RHOMBOHEDRAL BORON FROM 0.4 TO 16 μM. Werheit, H.; Hausen, A.; Binnenbruck, H. (Univ., Cologne). Phys. Status Solidi (b); 51: No. 1, 115-21(1 May 1972).

In the intrinsic range the anisotropy of the reflectivity amounts to about 2%, while the dichroism is very small at high photon energies and can only be measured when $\alpha \lessapprox 2 \times 10^3\ cm^{-1}$. Especially distinct is the anisotropy of the lattice vibrations. Similar to polycrystalline boron, two indirect interband transitions occur; the energy gaps are 1.561 and 1.39 eV with $E \| c$ and 1.541 and 1.34 eV with $E_{\perp} c$. The edge tail is dominated by an absorption band, possibly caused by C or Si impurities. (auth)

40138 WORK FUNCTION AND SURFACE STRUCTURE OF SIMPLE METALS. Paasch, G.; Eschrig, H.; John, W. (Technische Univ., Dresden). Phys. Status Solidi (b); 51: No. 1, 283-93(1 May 1972).

The work function is calculated for ten simple metals in the framework of model potentials, namely: Li, Na, K, Rb, Cd, Mg, Zn, Be, Al, and In. The Shaw model potential is used. The surface structure is described by a model containing a decrease of the conduction electron density and a change of the lattice constant. The parameters of this model are determined from the requirement of a minimum surface energy. The calculated work functions agree well with the experimental ones. The calculated increase of the lattice constant at the surface is about 1%. It gives rise to a decrease of the total surface dipole potential. The latter is much smaller than that calculated for the usual model, where the ions are replaced by a homogeneous background. The agreement of the work function with experiment justifies the use of the mean value of model potentials in the calculation of physical properties. (auth)

40139 ELECTRON MOMENTUM DISTRIBUTION IN VANADIUM. Paakkari, T.; Manninen, S.; Inkinen, O.; Liukkonen, E. (Univ. of Helsinki). Phys. Rev., B; 6: No. 2, 351-6(15 Jul 1972).

The Compton profile of polycrystalline vanadium was measured using 59.54-keV γ rays from an ^{241}Am source. In the regions of medium and high electron momentum, the observed profile coincides with that calculated from Hartree—Fock free-atom wave functions for the outer-electron configuration $3d^44s$. At small momentum values, the experimental results deviate significantly from those predicted by Hartree—Fock theory. (auth)

40140 ELASTIC MODULI AND MAGNETIC SUSCEPTIBILITY OF MONOCRYSTALLINE Nb_3Sn. Rehwald, W. (RCA Labs. Ltd., Zurich); Rayl, M.; Cohen, R. W.; Cody, G. D. Phys. Rev., B; 6: No. 2, 363-71(15 Jul 1972).

The elastic moduli c_{11}, c_{12}, and c_{44} and the magnetic susceptibility χ of single-crystal Nb_3Sn were measured as a function of temperature below 300°K. Detailed comparison is made between the experimental results and the predictions of simple one-dimensional band models. It is found that the behavior of the elastic moduli c_{11} and c_{12} above and below the cubic—tetragonal transformation at 45°K is well accounted for by the band model with an effective Fermi temperature of 80°K. Unlike the case of V_3Si, the modulus c_{44} is observed to undergo a considerable softening at low temperatures. This softening is not predicted by the theory. The susceptibility displays the predicted maximum near the lattice-transformation temperature. However, the decrease of χ in the tetragonal state, associated with a drop in the electronic density of states, is not nearly as large as expected. Furthermore, the cubic-state χ data indicate a much larger Fermi temperature (230°K) than is obtained from the c_{11} and c_{12} data. These anomalies are reviewed in terms of available band-structure calculations. The implications of the experimental results for superconductivity in Nb_3Sn are discussed. (auth)

40141 DIRECT OBSERVATION OF INTERACTIONS BETWEEN INDIVIDUAL ATOMS ON TUNGSTEN SURFACES. Tsong, Tien Tzou (Pennsylvania State Univ., University Park). Phys. Rev., B; 6: No. 2, 417-26(15 Jul 1972).

Using the field ion microscope (FIM), it is possible to investigate the interactions between individual atoms on metal surfaces. The number of atoms participating in an experiment can be specified and controlled by successive depositions or field evaporations. It is found that the interaction potential between two atoms depends on the substrate surface structure. In agreement with other investigators, the binding energy is found to be not pairwise additive. The interatomic potential between two Re atoms on W (110) planes shows at least two minima and a maximum, suggesting an oscillatory structure similar to the well-known Friedel oscillation. Surface migration as well as structures of clusters with less than six atoms is also investigated. It is found that the equilibrium structures of the clusters depend very sensitively on surface temperature. It is also found that potential traps of ~0.14 eV exist on crystal planes which otherwise appear to be perfectly regular in the FIM images. (auth)

40142 THIRD-ORDER ELASTIC CONSTANTS OF TIN AND OF A TIN—INDIUM ALLOY. Swartz, K. D.; Chua, W. B.; Elbaum, C. (Brown Univ., Providence). Phys. Rev., B; 6: No. 2, 426-35(15 Jul 1972).

The complete set of 12 third-order elastic constants (TOEC) of white (metallic) tin and a set of 11 of the 12 TOEC of tin containing 0.3 at.% indium were determined from the hydrostatic and uniaxial stress dependence of ultrasonic velocity. The experiments were carried out on single crystals, using the two-specimen interferometric method of measuring velocity changes. In both the pure and the alloyed crystals c_{333} was largest and negative, and only c_{123} was positive. Some of the TOEC for the alloy were found to differ from the corresponding ones for the pure tin by as much as 20%, e.g., (in units of 10^{12} dyn/cm^2), $c_{112(\mathrm{tin})} = -5.83 \pm 0.12$ and $c_{112(\mathrm{alloy})} = -4.82 \pm 0.13$. All the second-order elastic constants were measured for both types of specimens and were found to be the same within the experimental uncertainty of ≈0.1%. (auth)

40143 ISOTROPIC AND ANISOTROPIC GALVANOMAGNETIC PROPERTIES OF TYPE-I-SUPERCONDUCTING LEAD POLY- AND SINGLE CRYSTALS. Hering, Ekbert (Univ., Stuttgart). Z. Metallk.; 63: No. 5, 261-4(May 1972).

Measurements of the specific electrical resistivity and Hall coefficient in the intermediate state were made on polycrystalline and single-crystal lead foils as a function of external magnetic field strength, transport current density, angle between magnetic field and foil normal, and angle between rotation and transport current axis. The existing models for the dynamical intermediate state could be confirmed and extended to include the effect of formation of a laminar structure at a defined current density and to determine the contribution of moving normal flux in the intermediate state. The anisotropy of the Hall coefficient, measured on single crystals, could be confirmed by calculating the contributions of velocity vectors normal to the magnetic field. This demonstrates the great influence of the Fermi surface in the anisotropy of the Hall coefficient. Only single crystals with an RRR better than 10,000 showed the anisotropy. (auth)

40144 MAGNETIC HYPERFINE INTERACTION STUDIES OF MAGNETIC IMPURITIES IN METALS. Narath, A. (Sandia Labs., Albuquerque, N. Mex.). CRC Crit. Rev. Solid State Sci.; 3: No. 1, 1-37(Mar 1972).

A review is presented of the contribution of magnetic hyperfine studies to the current understanding of magnetic impurity states in paramagnetic metals between the nonmagnetic and magnetic limits. Both simple and transition-metal hosts are considered. After a consideration of the theory of magnetic hyperfine interactions in dilute alloys and of magnetic susceptibility, experimental studies using various methods (NMR, Moessbauer, nuclear orientation, PAC) are reviewed. (16 figures, 195 references) (D.L.C.)

40145 ORBITAL EFFECTS IN RARE EARTH MAGNETISM. Cooper, Bernard R. (General Electric Research and Development Center, Schenectady, N. Y.). CRC Crit. Rev. Solid State Sci.; 3: No. 1, 83-129(Mar 1972).

This review covers the magnetic effects of the crystal lattice acting through the large orbital contribution to the rare earth moments. Intermetallic compounds in which the crystal field alters the magnetic behavior are discussed. The equilibrium magnetic arrangements for the heavy rare earth elements are described, and a model for the equilibrium magnetic ordering of these metals is presented. Besides the crystal electric field, lattice distortion (magneto-elastic) effects are also treated. Transitions between different structures with applied field or temperature are discussed. Finally, the theoretical and experimental behavior of induced magnetic systems where the relative strengths of crystal-field and exchange interactions determine the ordering, is treated. (32 figures, 106 references) (D.L.C.)

40146 MAGNETIC STRUCTURES OF $CeZn_2$ AND $TbZn_2$. Debray, D.; Sougi, M.; Meriel, P. (CEN de Saclay, Gif-sur-Yvette, France). J. Chem. Phys.; 56: No. 9, 4325-8(1 May 1972).

$CeZn_2$ and $TbZn_2$ have the orthorhombic $CeCu_2$-type crystal structure. $CeZn_2$ becomes a simple antiferromagnet below the Néel temperature of 7.5°K. The magnetic unit cell is of the same size as the chemical cell. All moments are aligned along the b axis and the saturation moment per Ce at 4.2°K is $1.6 \pm 0.2\ \mu_B$. In the range 60 to 75°K, $TbZn_2$ exhibits a linear-transverse-wave moment alignment propagating along the c axis and polarized along the b axis direction. The wavelength of this static magnetization varies from 2.28 to 2.54 in units of c in this temperature range. The moment amplitude per Tb at 62.4°K is $6.91 \pm 0.17\ \mu_B$. At below 60°K, a first-order magnetic transition takes place and the resulting antiferromagnetic structure has a magnetic unit cell twice the size of the chemical cell, the c axis being doubled. All moments are aligned along the b axis and the saturation moment per Tb at 4.2°K is $8.15 \pm 0.10\ \mu_B$. The magnetic structures of both $CeZn_2$ and $TbZn_2$ can be described as resulting from the stacking of ferromagnetic sheets of the rare-earth ions in some antiferromagnetic fashion. (auth)

40147 ELECTRICAL, MAGNETIC, AND GALVANOMAGNETIC PROPERTIES OF DOUBLE HYDRIDES OF TRANSITION METALS: ZrH_2—TiH_2, ZrH_2—HfH_2, ZrH_2—NbH. Savin, V. I.; Andrievskii, R. A.; Lyutikov, R. A. Zh. Neorg. Khim.; 17: No. 4, 920-4(Apr 1972). (In Russian).

A series of physical properties of the double hydrides of some transition metals of Groups IV and V were studied. The electrical resistance, thermal emf, magnetic susceptibility, and Hall coefficients were measured as functions of composition for the pairs: ZrH_2—NbH, TiH_2—ZrH_2, and ZrH_2—HfH_2. The magnetic susceptibility, as a rule, was less than the corresponding value for the original metallic alloys. The observed changes in properties of the hydride alloys were ascribed to changes in the electron—phonon interaction during formation of the alloy. (K.S.W.)

40148 ELECTRICAL, MAGNETIC, AND GALVANOMAGNETIC PROPERTIES OF THE HYDRIDES OF TITANIUM, HAFNIUM, AND NIOBIUM. Andrievskii, R. A.; Savin, V. I.; Lyutikov, R. A. Zh. Neorg. Khim.; 17: No. 4, 915-19(Apr 1972). (In Russian).

The concentration and temperature dependencies of the electrical resistance, thermal emf, magnetic susceptibility, and Hall coefficients were studied for Ti, Hf, and Nb hydrides. A number of regularities were found in the variation of such properties in the region of homogeneity. The hydrides of these transition metals showed metallic character in their conductivity. Some interpretation of the phenomena is offered in light of the theory of metals and alloys. (K.S.W.)

40149 MAGNETORESISTANCE AND HALL EFFECT OF ZIRCONIUM HYDRIDE. Nemchenko, V. F. (Kherson Pedagogical Inst., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 11, 1812-16(Nov 1971). (In Russian).

Dependences of the Hall coefficient and magnetoresistance on magnetic-field intensity were determined in zirconium hydride samples containing 1.37, 1.63, and 1.95 at. % of hydrogen at temperatures 77 and 300°K. The Hall coefficient does not depend on the field and magnetoresistance increases with the field growth by a quadratic law. Concentration and mobilities of current carriers are calculated from the experimental data on the basis of a two-band model in assumption of equal concentrations of electrons and holes. Carrier concentration linearly increases with a rise in the hydrogen content; mobilities pass through the minimum at an average hydrogen concentration. (auth)

40150 MAGNETIC SUSCEPTIBILITY OF NIOBIUM. Collings, E. W.; Smith, R. D. (Battelle Columbus Labs., Ohio). J. Less-Common Metals; 27: No. 3, 389-401(Jun 1972).

Magnetic susceptibilities of several grades of niobium were measured in the temperature range 78 to 400°K. For very-high-purity metal, $\chi_{300°K} = 214.1 \pm 0.3\ \mu$ emu/mole. The temperature dependence is not uniformly linear within 78 to 400°K but changes slope at 160°K, a temperature at which a change also seems to take place in the linear thermal expansion behavior. The temperature dependences of high-purity niobium are: $\partial_\chi/\partial T(78 \text{ to } 160°K) = -1.9 \times 10^{-2}\ \mu$ emu/mole deg, and $\partial_\chi/\partial T(160 - 300°K) = -3.4 \times 10^{-2}\ \mu$ emu/mole deg. Also considered are contamination by tantalum and oxygen. (auth)

40151 EXCHANGE INTERACTIONS AND FLUCTUATIONS IN CeB_6. Lee, K. N.; Bell, Brian (Stanford Univ., Calif.). Phys. Rev., B; 6: No. 3, 1032-40(1 Aug 1972).

Measurements of the low-temperature specific heat of CeB_6 are reported, and their significance is discussed in the light of earlier studies of this compound. The large specific heat above the antiferromagnetic ordering at 2.31°K is interpreted with the aid of a decorated Ising model. This model permits one to combine exchange and crystal-field interactions in a simplified, but exact, calculation of the thermodynamic properties of a magnetic system including the effects of fluctuations. The analysis gives independent support to the proposal by Nickerson and White that the exchange in the crystal-field excited state is substantially stronger than the ground-state exchange in CeB_6. The possibility of extending such an analysis to other magnetic rare-earth hexaborides is considered. (auth)

40152 AUGMENTED-PLANE-WAVE CALCULATIONS OF THE ELECTRONIC STRUCTURE OF INTERMETALLIC COMPOUNDS YCu AND YZn. Belakhovskii, M. (CEN, Grenoble, France); Pierre, J.; Ray, D. K. Phys. Rev., B; 6: No. 3, 939-45(1 Aug 1972).

In order to understand the electronic structure of the rare-earth intermetallic compounds RX, where X = Cu, Ag, Au or Zn, Cd and R is a rare-earth element, the energy bands of the isomorphous compounds YCu and YZn were calculated by the augmented-plane-wave method along different symmetry directions. The calculated Fermi energies for YCu and YZn are +0.42 and +0.47 Ry, respectively. The densities of states $N(E_F)$ at the Fermi level are obtained as 1.9 ± 0.2 and 2.35 ± 0.2 electrons/eV unit cell for YCu and YZn, respectively. This value for YCu is in good agreement with the experimental value of 1.32 electrons/eV unit cell obtained from specific-heat measurements. Also, the calculated change of density of states near the Fermi level is in the same direction as that obtained from specific-heat results on YCu substituted with small quantities of Ni or Zn. The implications of the calculated energy bands are discussed. (auth)

40153 TEMPERATURE DEPENDENCE OF THE EFFECTIVE f–f EXCHANGE INTERACTION IN RARE-EARTH METALS. Fedro, A. J. (Northern Illinois Univ., DeKalb. Argonne National Lab., Ill); Arai, Tadashi. Phys. Rev., B; 6: No. 3, 911-23(1 Aug 1972).

It is shown that, in the presence of a spiral spin ordering, a new type of spin-flip process similar to that considered by Kondo but not suppressed by the molecular field appears and yields the lnT dependence in the exchange-coupling parameter. This lnT dependence is shown to explain the temperature dependence of the pitch parameter as well as the suppression of the maximum in $J(\vec{q})$, the Fourier transform of the effective f–f exchange interaction with temperature. This theory leads to a ferromagnetic transition even though the present treatment is somewhat unrealistic since it neglects the anisotropy effects. The transition temperatures T_C are estimated by a simple gap equation similar to that of the BCS theory in superconductivity and are shown to be in good agreement with observed values. The inordinately high value of T_C for Gd suggests why Gd does not exhibit a spiral structure. (auth)

40154 DENSITY OF STATES OF ReO_3 BY X-RAY PHOTOELECTRON SPECTROSCOPY. Kasowski, R. V.; Riggs, W. M. (E. I. du Pont de Nemours and Co., Wilmington, Del.). Phys. Lett.; 39A: No. 5, 387-8(5 Jun 1972).

The x-ray photoelectron spectrum of ReO_3 was measured and compared to the theoretical density of states of Mattheiss. (auth)

40155 USE OF INCOHERENT SCATTERING OF SLOW NEUTRONS FOR THE DETERMINATION OF NONBONDED POTENTIAL PARAMETERS. Tarina, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 1, 57-61 (1972).

A method for determination of nonbonded intermolecular potential parameters at hydrocarbon crystals, using elastic incoherent scattering of slow neutrons, is proposed. The advantages and disadvantages of the proposed method are discussed. (auth)

40156 ROLE OF SPECTRAL DENSITY OF A TRANSVERSE MAGNETIC FIELD DURING CHANGES IN ORIENTATION OF MAGNETIZATION OF NUCLEI IN SPACE. Zhernovoi, A. I. (Leningrad Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 138-40(1971). (In Russian).

The magnetization of nuclei in the direction of an external magnetic field is assumed, the nuclei having spin = ½ after the action of a rectilinear radio pulse of a transverse magnetic field with amplitude $2H_1$. It is shown that, in the case of a rapid adiabatic passage, the integral probability for re-orientation of spins (spin flip) is proportional to the square of the spectral density. (K.S.W.)

40157 OPTICAL CONSTANTS OF CLEAN TITANIUM AND TUNGSTEN SURFACES AS FUNCTIONS OF TEMPERATURE. Smith, Tennyson (North American Rockwell Science Center, Thousand Oaks, Calif.). J. Opt. Soc. Amer.; 62: No. 6, 774-80 (Jun 1972).

The optical constants of single-crystal Ti (0001) and W (110) and polycrystalline W and Ti were measured as functions of temperature at two wavelengths (5461 and 6328 Å). The crystals were cleaned by ion bombardment and annealed to remove surface damage and bombardment impurities. The degree of surface contamination was monitored by Auger spectroscopy. (auth)

40158 REFLECTANCE OF EVAPORATED RHENIUM AND TUNGSTEN FILMS IN THE VACUUM ULTRAVIOLET FROM 300 TO 2000 A. Cox, J. T. (Army Electronic Command, Fort Belvoir, Va.); Hass, G.; Ramsey, J. B.; Hunter, W. R. J. Opt. Soc. Amer.; 62: No. 6, 781-5(Jun 1972).

The reflectance of evaporated rhenium (Re) and tungsten (W) was measured in the wavelength region from 300 to 2000 Å. Re and W of 99.99% purity were evaporated with a 6-kW fine-focused electron gun and deposited on glass and fused-quartz plates of various temperatures ranging from 40 to 500°C. With Re, films of highest reflectance were obtained by evaporation onto unheated substrates, whereas with W, heating of the substrate greatly increased the reflectance of the deposited films. Both materials showed higher reflectances as rather thin, semitransparent films than as opaque ones. With coatings produced under optimum conditions, Re films had a reflectance maximum of 36% at 630 Å and tungsten films had two reflectance maxima, at 630 and 970 Å, of about 33% each. This is higher than that of any mirror coating presently used at these wavelengths. For both metals, the reflectance losses during extended exposure to air remained rather small, indicating that the oxide films formed on both film materials at room temperature were very thin. Re is a particularly useful coating material for replica gratings that cannot be heated during the deposition, because highest reflectance is obtained with unheated substrates. (auth)

40159 ADSORPTION OF TRANSITION METAL ATOMS ON A TRANSITION METAL SUBSTRATE. Cyrot-Lackmann, F. (Institut Max von Laue–Paul Langevin, Grenoble, France). J. Vac. Sci. Technol.; 9: No. 3, 1045-8(May-Jun 1972).

The binding energy of transition atoms adsorbed on a transition metal of the same series is studied in a tight binding model using a moment's expansion technique. The general trends of the variation of the binding energy with the number of adatom d electrons are similar for all the substrates. As the number of d electrons is increased, they show a parabolic variation with a maximum of the order of the cohesive energy of the substrate and a sharper decrease after the maximum. These results are in good agreement with the experimental results on 5 d adatoms on tungsten. Interaction energies between adatoms are also studied and shown to be only of some importance for neighboring adatoms and rather small compared to the binding energy of a single adatom. (auth)

40160 OBSERVATION OF COOPERATIVE NUCLEAR MAGNETIC ORDER IN $PrCu_2$ BELOW 54 mK. Andres, K.; Bucher, E.; Maita, J. P.; Cooper, A. S. (Bell Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 25, 1652-5(19 Jun 1972).

Magnetic-susceptibility and specific-heat measurements in Van Vleck paramagnetic $PrCu_2$ down to 30 mK reveal that the Pr nuclei enter an antiferromagnetically ordered state below 54 mK. This high nuclear ordering temperature results from magnetic exchange interactions between the Pr ions, which must be close to the critical value necessary for spontaneous electronic magnetic order in this compound. (auth)

40161 NATURE OF MAGNETIC ANISOTROPY IN DYSPROSIUM: AN INVESTIGATION OF ANISOTROPY OF DYSPROSIUM–GADOLINIUM ALLOYS. Levitin, R. Z.; Savitskii, E. M.; Terekhova, V. F.; Chistyakov, O. D.; Yakovenko, V. L. (Moscow State Univ. Inst. of Metallurgy, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 5, 1858-66(May 1972). (In Russian).

The magnetization of DY_xGd_{1-x} ($0.046 \leq x \leq 0.49$) single crystals is measured along various crystallographic directions in pulsed magnetic fields up to 280 kOE. The uniaxial anisotropy coefficient k_2^0 is determined from the data thus obtained. It is shown that within the experimental errors the dependence of the anisotropy coefficient k_2^0 on temperature and alloy composition is in agreement with the theoretical dependences predicted by the one-ion anisotropy model. (auth)

40162 ZENER RELAXATION IN SILVER–INDIUM SOLID SOLUTION. Robinson, W. H. (DSIR, Lower Hutt, N. Z.). Phys. Status Solidi (a); 11: No. 1, K59-60(16 May 1972).

From calculations using data from Mills [Phys. Stat. Sol., (a)6: 55(1971)] in which he suggested that a Zener relaxation peak found in the silver–indium system was controlled by the diffusion of silver, it is concluded that it is possible that the strength of the observed Zener relaxation is governed by the formation of vacancies. (D.H.M.)

Moessbauer Effects and NMR

Refer also to abstracts 39811 and 39869.

40163 (INP-792) INTERFERENCE EFFECTS IN NUCLEAR MAGNETIC RESONANCE. Blicharski, Jerzy Stanislaw (Jagellonian Univ., Krakow (Poland). Inst. of Physics. Institute of Nuclear Physics, Krakow (Poland)). Feb 1972. 184p. (In Polish). Dep. NTIS (U. S. Sales Only).

Effects of interference between different interactions in nuclear magnetic resonance are considered. General expressions for the nuclear relaxation times T_1, T_2, $T_{1\rho}$, and $T_{2\rho}$ are presented and moments of the resonance line and longitudinal and transversal relaxation functions are calculated in the presence of the interference between different interactions. In the case of liquid CF_2Cl_2 and $^{10}BF_3$, deviation of the relaxation functions from the single exponential decay was found experimentally according to the predictions of the theory. (auth)

40164 NMR STUDY OF FERROMAGNETIC Gd INTERMETALLIC COMPOUNDS WITH CsCl STRUCTURE. Oppelt, A. (Technische Hochschule, Darmstadt, Ger.); Dormann, E.; Buschow, K. H. J. Phys. Status Solidi (b); 51: No. 1, 275-82(1 May 1972).

By means of spin-echo techniques the zero field resonance of ^{155}Gd, ^{157}Gd, ^{107}Ag, ^{109}Ag, and ^{67}Zn nuclei could be detected in the ferromagnetically ordered CsCl-type compounds $GdAg_{1-x}In_x$, $GdAg_{1-x}Zn_x$, and $GdZn_{1-x}In_x$. In some cases, well-resolved lines could not be obtained due to broadening. The hyperfine fields of both the magnetic and the nonmagnetic ions are negative. No significant hyperfine field variation with conduction electron concentration is observed for the nonmagnetic ions, while for the Gd ions it is appreciable. This cannot be explained by the simple RKKY approach, in which the interaction between the localized Gd moments and the conduction electrons is considered to be a δ-function interaction and in which the Fermi surface is assumed to be spherical. The variation of the hyperfine fields was also studied in the systems $GdCd_{1-x}Zn_x$ and $GdIn_{0.5(1-x)}Ag_{0.5(1-x)}Zn_x$, in which the number of conduction electrons remains constant. Essentially no change is found in $GdCd_{1-x}Zn_x$, where divalent Cd is replaced by divalent Zn. In $GdIn_{0.5(1-x)}Ag_{0.5(1-x)}Zn_x$, where divalent Zn is replaced by monovalent Ag and trivalent In, the hyperfine fields become smaller with decreasing x. Apparently, the reduction of the conduction-electron mean free path due to potential scattering modifies their polarization. (auth)

40165 NUCLEAR MAGNETIC RESONANCE STUDY OF VN-TYPE OF VANADIUM NITRIDE. Shevakin, A. F.; Tomulin, I. A.; Carrak, V. I. Fiz. Metal. Metalloved.; 32: No. 6, 1204-8 (Dec 1971). (In Russian).

The effect of composition on the NMR spectra of ^{51}V in the nitride VN_x was investigated in different magnetic fields. Analysis of the shape of resolved lines of the spectra was characteristic of vanadium nuclei, the environment of which was distinguished by the number of free interstitials. The Knight shifts of these lines were determined. The ordering of the arrangement of the free interstitials is established. (tr-auth)

40166 LINEAR COMBINATION OF LORENTZIAN AND GAUSSIAN PROFILES TO FIT RESONANCE SPECTRA. Peyre, J. J.; Principi, G. (Univ. Central, Caracas). Nucl. Instrum. Methods; 101: No. 3, 605-6(1972).

A linear combination of Lorentzian and Gaussian profiles is considered as a convenient function for the approximation of a Voigt profile and thus for fitting resonance spectra. (auth)

40167 NUCLEAR MAGNETIC RESONANCE STUDY OF HfV_2. Saji, H.; Yamadaya, T. (Matsushita Research Inst. Tokyo, Inc., Kawasaki, Japan). Phys. Lett.; 39A: No. 5, 359-60(5 Jun 1972).

The magnetic susceptibility was found to exhibit an anomaly in the neighborhood of 120°K for the cubic Laves phase HfV_2. The obtained values of e^2qQ/h were 2.99 ± 0.002 and 1.19 ± 0.002 MHz at 77 and 295°K, respectively. (auth)

40168 SHAPE OF MOESSBAUER RESONANCE WITH INTERFERENCE. Cleveland, B. T.; Heberle, J. (State Univ. of New York, Buffalo). Phys. Lett.; 40A: No. 1, 13-14(19 Jun 1972).

The derivation of a formula for the line shape is outlined. Previously reported measurements that were fit with the thin-absorber approximation for the line shape may have a large systematic error in the value of the interference parameter. (auth)

40169 METHOD FOR DETERMINING AN EXPLICIT VALUE OF CHEMICAL SHIFT IN γ-RESONANCE ABSORPTION BY SOLIDS. Sharma, H. N. K.; Srivastava, B. P.; Bhattacharya, D. L. (Banaras Hindu Univ., India). Curr. Sci. (India); 41: No. 9, 327-8(5 May 1972).

Equations are derived for the total (center) energy shift of Moessbauer source and absorber. Conditions for the elimination of the second-order Doppler shift are given: (1) The source and absorber are at the same temperature and located in the same host lattices. (2) If the source and absorber are in different host lattices, the temperatures are different and related to each other by $T[1 + M''/20\,M'\,(\theta_D^A/T')^2] = T[1 + M/20\,M'\,(\theta_D^S/T)^2]$. Temperature calculations are presented for a ^{57}Co source in Pd and a ^{57}Fe absorber in Fe. (D.L.C.)

40170 MAGNETIC PROPERTIES AND CRYSTALLINE FIELDS IN $YbPd_3$. Nowik, I.; Dunlap, B. D.; Kalvius, G. M. (Argonne National Lab., Ill.). Phys. Rev., B; 6: No. 3, 1048-53(1 Aug 1972).

Moessbauer-effect studies of ^{170}Yb in the cubic intermetallic $YbPd_3$ at temperatures 1.4 to 4.2°K and in external fields up to 44 kOe yield the following results: (a) Although the Yb ion is trivalent, no magnetic ordering is seen down to 1.4°K. (b) The temperature and field dependence of the magnetic hyperfine field and the induced electric field gradient show that the ground state in the presence of external field is not an isolated level. (c) All experimental observations can be reproduced by a cubic-crystal-field calculation with parameters $A_4\langle\gamma^4\rangle = -12 \pm 1\ \mathrm{cm}^{-1}$ and $A_6\langle\gamma^6\rangle = 0.6 \pm 0.6\ \mathrm{cm}^{-1}$. These give a Γ_7 ground state with Γ_8 and Γ_6 lying at 29 and 39 cm^{-1}. These results are compared to predictions of a simple-point-charge-model calculation. Low-field spectra have been analyzed to give an ionic spin–relaxation time $\tau_R \simeq 4 \times 10^{-11}$ sec. (auth)

40171 NUCLEAR-MAGNETIC-RESONANCE ANALYSIS OF HYDROGEN MOTION IN HYDRIDES. Weaver, H. T.; VanDyke, J. P. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., B; 6: No. 3, 694-8(1 Aug 1972).

A comparison of the results from analyzing spin–lattice relaxation times (T_1) of diffusing spins using an exponential correlation function and the isotropic model of Torrey was made. Data from $ScH_{1.7}$, $TiH_{1.55}$, and $TiT_{1.5}$ were used. No significant difference was found for activation energies, the isotope effect, or minimum T_1 using the two models. (auth)

40172 EFFECT OF MOLECULAR SHAPE AND FLEXIBILITY ON GAMMA-RAY DIRECTIONAL CORRELATIONS. Marshall, Alan G. (Univ. of British Columbia, Vancouver); Werbelow, Lawrence G.; Meares, Claude F. J. Chem. Phys.; 57: No. 1, 364-70(1 Jul 1972).

The perturbed angular correlation for a gamma-ray cascade from a nucleus rigidly bound to an asymmetric-top molecule in solution was calculated, using a diffusional model for rotational reorientation. When molecular rotation is rapid [all diffusion constants $D_i \gg (1/6\tau_n)$, where τ_n is the lifetime of the intermediate nuclear state of the cascade], a treatment analogous to that in nuclear magnetic resonance leads immediately to the desired attenuation factor. On the other hand, when molecular rotation is slow [all $D_i \ll (\omega_0/6)$, where ω_0 is the fundamental quadrupole frequency], the derived form of the angular correlation may not contain a separable attenuation factor. These calculations are illustrated by several plots of the integral anisotropy for symmetric-top molecules of fixed shape and varying size, for several choices of the characteristic "angle of attachment" between the molecular symmetry axis and the principal axis of the electric field gradient at the nucleus. Finally, it is shown that the case of a tracer bound through a single flexible link to a spherical molecule is formally identical to the case of a tracer rigidly bound to a symmetric-top molecule; the resultant integral anisotropy is plotted for several fixed rates of internal rotation in spherical molecules of varying size, for several choices of the "angle of attachment" between the electric field gradient and the axis about which internal rotation occurs. The conclusions of practical significance are (1) the perturbed angular correlation depends only weakly on the shape of the molecule, while (2) in contrast, the correlation can be markedly affected by the presence of even relatively slow internal rotation at the site of attachment of the tracer to the molecule. (auth)

40173 MOESSBAUER SCATTERING PROBABILITY IN COUPLED HYPERFINE INTERACTIONS. Barb, D.; Constantinescu, S.; Tarina, D. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 17: No. 1, 3-6(1972).

Expression of the Mössbauer scattering probability for γ-multipole mixtures is given in the case of coupled hyperfine interactions. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 38542, 39481, 39621, 39683, 39688, 39703, and 39745.

40174 (IFA-M-47) NUMERICAL ACCURACY OF THE REGULAR COULOMB FUNCTION. Carstoiu, B.; Deberth, C.; Hategan, C.; Sandulescu, A. (Institutul de Fizica Atomica, Bucharest (Romania)). Sep 1971. 11p. Dep. NTIS (U. S. Sales Only).

A FORTRAN IV subroutine for the regular Coulomb function $F_1(\eta,\rho)$ and its derivative $[dF_1(\eta,\rho)/d\rho]$ based on the well known power series expansion of this function is presented. A study of the number of lost significant digits is made as a function of η, l and ρ. The results, presented in 9 tables, for $\eta = 1(3)25$, $l = 0(5)50$ and $\rho = 5(5)50$ show that the number of lost significant digits decreases as l and η increase and increases with the increase of ρ. (auth)

40175 (IPP-6/106) CONSTRUCTIVE METHOD OF SOLVING THE LIAPOUNOV EQUATION FOR COMPLEX HESSENBERG MATRICES. Meyer-Spasche, R. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Feb 1972. 12p. Dep. NTIS (U. S. Sales Only).

A method of solving the Liapounov equation (1) $HM + M^*H = 2D$, M in upper Heisenberg form, D diagonal is described. Initialising the first row of the matrix A arbitrarily, one can find (by solving equations with one unknown) the unknown elements of A such that (2) $AM + M^*A^* = 2F$, where A differs from a Hermitian matrix only in that its diagonal elements need not be real. F is a diagonal matrix which is uniquely determined by the first row of A. By solving equation (2) for several initial values one may generate several matrices A and F (in the most unfavorable case $2n - 1$ A's and F's are needed) and superpose them to get n linearly independent Hermitian matrices H_j and D_j respectively for which $H_jM + M^*H_j = 2\,D_j$ is valid. Then one can solve the real system $(n/z)_{j=1}\,P_jD_j = D$ to obtain the solution $H{:} =(n/z)_{j=1}\,P_jH_j$ of eq. (1). (auth)

40176 (ITF-71-86-P) METHOD OF ASYMPTOTIC OPERATORS IN STATISTICAL MECHANICS. I. THE SPATIALLY HOMOGENEOUS STATES. Peletminskii, S. V.; Prikhod'ko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 30p. (In Russian). Dep. NTIS (U. S. Sales Only).

Role of the principle of weakening of correlations and ergodic relations in finding the secular terms (asymptotic operators) in the series of perturbation theory for the density matrix is discussed. Asymptotic operators are applied to obtain a rough density matrix at a simplified step of evolution and low for finding singularities in the frequency region of the part of density matrix describing the response of the system to an external perturbation. (auth)

40177 (ITF-71-87-P) METHOD OF ASYMPTOTIC OPERATORS IN STATISTICAL MECHANICS. II. SPATIALLY INHOMOGENEOUS STATES. Peletminskii, S. V.; Prikhod'ko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

The kinetics of spatially inhomogeneous states is investigated using the on ergodic relations and the properties of weakening of correlations. It is a development of previous work. On the basis of the method analogous to that of previous work the integral equations are obtained for the density matrix at a simplified step of evolution. The questions of behavior of the system in an external field changing slowly in space-time are examined too. (auth)

40178 (JINR-P4-6330) THEORY OF ANTICLASSICAL APPROXIMATION FOR ABOVE THE BARRIER REFLECTION COEFFICIENT. Babikov, V. V.; Musabaev, K. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The anticlassical approximation, inverse to the quasiclassical one, is studied by the phase function method. A simple method is presented for obtaining of the above barrier reflection coefficient terms (in an explicit form) expanded into series over the degrees of dimensionless parameter of anticlassical character $\epsilon = 2p_c\alpha/\hbar \ll 1$, where p_c is some characteristic momentum, α is the dimension of the area of a sharp change of a potential. Some examples are given. (auth)

40179 QUANTUM MECHANICS OF LOOSELY COUPLED SPIN SYSTEMS. Floodstrand, Frederic Hjalmar. University Park, N. Mex.; New Mexico State Univ. (1971). 154p. University Microfilms Order No. 72-13,701.

Thesis.

Some of the paradoxical features of quantum mechanics which become particularly conspicuous in composite systems consisting of two or several loosely coupled, spatially separated subsystems are considered. Most familiar among these features are the following: The indeterministic nature of the laws of quantum mechanics which is often referred to as the breakdown of causality. The subjective description of nature and the concomitant denial of reality for such concepts as a particle orbit, or a spin direction in a two-spin singlet state. And finally, the quantum mechanical theory of measurement which involves such controversial concepts as the "contraction of the state function," and the need for the language of classical physics. While these features are common to all quantum mechanical systems there exists one less familiar paradox which shows up only in loosely coupled composite systems. It is a statistical correlation between the properties of loosely coupled subsystems which persists over long distances, in principle over miles or light years, and which is able to spread with a velocity exceeding that of light. This long range correlation, and its operational meaning, is the main subject discussed. (TSS)

40180 FAST AND ACCURATE SOLUTIONS FOR MELDNER'S REALISTIC SINGLE-PARTICLE HAMILTONIAN. Cusson, R. Y.; Trivedi, H.; Kolb, D. (Duke Univ., Durham, N. C.). Phys. Rev., C; 5: No. 6, 2120-1(Jun 1972).

The integrodifferential equation obtained by Meldner is reduced to two coupled differential equations, which are solved by using Buck's algorithm in about one hundreth of the time previously necessary. This powerful method for finding self-consistent solutions allows extensive searches on the model parameters, and should make it possible to perform realistic calculations for deformed heavy nuclei. Preliminary results show improved agreement with the experimental radii ^{16}O and ^{40}Ca. (1 table) (auth)

40181 BOUND STATES IN THE CONTINUUM OF N-BODY SYSTEMS AND THE VIRIAL THEOREM. Albeverio, Sergio (Princeton Univ., N. J.). Ann. Phys. (N. Y.); 71: No. 1, 167-276(May 1972).

Generalized versions of the quantum mechanical virial theorem are proved and applied to the investigation of the spectrum of N body Hamiltonians. It is shown, in particular, that for N particles interacting through 2-body potentials which may have singularities but "don't wiggle too much," no positive energy bound state can exist. Results on the absence of bound states with energy bigger than some value $E^0 \geq -\infty$ are proved and extended to the case of N particles interacting through v-body forces ($v = 1,2,\ldots, N$) and with an external electromagnetic field. Also some remarks for the case of a Dirac electron in an external potential are given as well as for some problems with boundary conditions. A byproduct of this investigation is the unitarity of the S matrix and the strong asymptotic completeness for systems of N particles interacting by 2-body forces which are not restricted to be purely repulsive. (auth)

40182 UNCERTAINTY PRINCIPLE. IV. Halpern, Otto. Acta Phys. Austr.; 33: No. 3-4, 305-16(1971).

Continuing earlier investigations into the same problem difficulties arising in the optical measurement of momentum are first discussed in some detail. It is found that important additional sources of inaccuracy have not been taken into account because multiple scattering had been neglected. Extending the discussion to the measurement of momentum with the aid of a magnetic field the conclusion is reached that here too the value of the uncertainty product is no longer universal but depends on the experimental arrangement and is always very much larger than h. Some old theoretical attempts to measure accurately electrical field strengths are analyzed: it had before been shown that such measurements are not possible because they are invariably connected with an enormous production of pairs the presence of which invalidates the measurement results. It is found that such ideal measurements are hardly feasible even if the presence of pairs is deliberately neglected. Finally a discussion of the necessary revision of the interpretation of quantum mechanics is offered. (auth)

40183 VALIDITY OF HAMILTON-JACOBI MECHANICS IN THE MEAN IN QUANTUM MECHANICS. Taylor, W. J.; Levine, R. D. (Ohio State Univ., Columbus). Int. J. Quant. Chem.; 6: No. 3, 449-53(May 1972).

It is shown that under certain conditions the time-dependent Hamilton-Jacobi equation (TDHJE) is satisfied in the mean in quantum mechanics provided the classical action is replaced by Dirac's complex quantal action. This may be regarded as the equivalent of Ehrenfest's theorem for the TDHJE. Expectation values of operators are discussed in a similar manner. (auth)

40184 INTERFERENCE EFFECTS PRODUCED BY MODULATED PARTICLE BEAMS. Lipkin, H. J. (Argonne National Lab., Ill. National Accelerator Lab., Batavia, Ill.); Peshkin, M. J. Appl. Phys.; 43: No. 7, 3037-40(Jul 1972).

The general principles of quantum mechanics imply restrictions upon the time and space dependence of interference effects produced by modulated particle beams. The theorems proved cover a wide range of phenomena, including the production of coherent radiation. (auth)

40185 THERMODYNAMICS OF A QUANTUM SIMULATING FLUID COMPLEX. Gilson, J. G. (Queen Mary Coll., London). Int. J. Theor. Phys.; 5: No. 5, 325-37(1972).

Earlier work (Gilson, (1969) (1971)) on a two fluid quantum simulating system is elaborated and clarified. Both of the fluids involved are assumed to have positive and negative mass in their structure. The thermodynamical and statistical consequences of using such a mixed mass system are analyzed. Connections with the work of other authors are established. In particular, bulk viscosity is now incorporated as a vital characteristic of one of the fluids. (auth)

40186 UNIFIED THEORY OF HARMONIC OSCILLATOR TWO-CENTER INTEGRALS. III. THE GAUSS POTENTIAL. Witschel, W. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Naturforsch.; 27a: No. 2, 180-7(Feb 1972).

The occupation number representation and operator-technique are used in the calculation of harmonic oscillator matrix elements for one and two centers and for equal and different frequencies. The potentials treated are generalized Gauss potentials of the form $\hat{p}^k \hat{x}^l \exp\{\alpha \hat{x}^2\}$, $\hat{x}^k \hat{p}^l \exp\{\alpha \hat{p}^2\}$, and $\hat{p}^k \hat{x}^l \exp\{\alpha \hat{x}\hat{p}\}$ which by application of an operator identity could be reduced to the same form. Applications in nuclear and molecular physics, in molecular spectroscopy and in quantum chemistry are discussed briefly. (auth)

40187 DERIVATION OF A GENERAL KINETIC EQUATION BY A PROJECTION TECHNIQUE: A GENERAL THEORY. Demendy, Z. (Univ. of Heavy Industry, Miskolc, Hungary). Physica; 59: No. 1, 1-13(1 May 1972).

A closed equation which describes the long-time evolution of a single-particle distribution function will be derived from a generalized Zwanzig relaxation equation. It will be shown that the weakening of the initial correlations is a sufficient and necessary condition for the factorization of an asymptotic global distribution function and for the attaining of closure for the BBGKY hierarchy. (auth)

40188 PERMUTATION SYMMETRY AND THE N−ELECTRON PROBLEM. Sullivan, John J. (Southern Illinois Univ., Carbondale). Phys. Rev., A; 5: No. 1, 29-37(Jan 1972).

The techniques of tensor algebra customarily applied to exploit spatial symmetry are applied to exploit permutational symmetry of the N-electron problem. In the approximation of no spin−orbit coupling, the results are nontrivial and give a further reduction of what is normally regarded as the reduced matrix element with respect to spatial symmetry alone. The required 3-j coefficients of the permutation group are evaluated so that intermediate group-theoretical indices that have no direct physical significance are eliminated from the formulation. The spin integral for any operator can always be reduced to known integrals of the fundamental Pauli operators. Thus all matrix elements can be reduced to a corresponding spin-free form with known weighting coefficients. An explicit expression is given for the matrix element of an operator suitable for evaluating spin−own-orbit coupling or spin density at the nucleus. A recursion relation for the Clebsch−Gordan coefficients of bipartition representations of S_N in terms of its subgroups and the 9-j symbols of SU(2) is developed. For one of the representations being the totally symmetric representation, the Clebsch−Gordan coefficient is known and the recursion relation (the group-orthogonality relation in this case) can be considered as giving nontrivial sum rules on the 9-j symbols of SU(2). (auth)

40189 SOME COMMENTS ON THE TIME-DEPENDENT VARIATION PRINCIPLE. Loewdin, P.-O. (Univ. of Uppsala. Univ. of Florida, Gainesville); Mukherjee, P. K. Chem. Phys. Lett.; 14: No. 1, 1-7(1 May 1972).

The time-dependent variation principle due to Frenkel is discussed from a new standpoint based only on the assumption that the norm of the variational function Φ exists. By studying the expectation value of the frequency operator $j = i\partial/\partial t$, one may introduce the conventional normalization and a "phase normalization" through a special gauge transformation leading to the result $J = \langle H - j \rangle = 0$. It is shown that the condition $\delta J = 0$ leads to Frenkel's variation principle, which is further discussed by studying the error function $\Theta = (H - i\partial/\partial t)\Phi$. (auth)

40190 SPECTRUM GENERATING ALGEBRAS AND SYMMETRIES IN MECHANICS. II. Hermann, Robert (Rutgers−The State Univ., New Brunswick, N. J.). J. Math. Phys. (N. Y.); 13: No. 6, 838-42(Jun 1972).

In case a group of symmetries of a classical mechanics system acts on a locally transitive way on the energy surface, it is shown how the time evolution of the system is related to orbits of one-parameter subgroups of the symmetry group. In particular, this provides a group-theoretic interpretation of certain types of regularization of collisions. Generalizations of this phenomenon to quantum mechanics are also discussed. (auth)

40191 CONCERNING MEASUREMENTS IN QUANTUM THEORY: A CRITIQUE OF A RECENT PROPOSAL. Hooker, C. A. (Univ. of Western Ontario, London). Int. J. Theor. Phys.; 5: No. 4, 231-50(1972).

The treatment suggested by Jauch (1968) of the problem of measurement in quantum theory, which is the understanding of the origin and nature of the so-called gap, is critically examined. It is concluded that Jauch's theory of measurement would have provided an elegant and very simple solution to all the standard difficulties found in other versions of the measurement process in quantum theory but examination of this theory shows that it not only contains an important element of obscurity (that is concerned with just exactly under what conditions the reductions may be performed) and ambiguity (concerning which reductions are to be performed) but also that it is both inconsistent and lacking in physical plausibility. (UK)

40192 SEQUENCES OF HILBERT SPACES WITH APPLICATIONS TO QUANTUM MECHANICS. Breitenecker, M.; Gruemm, H.-R. (Univ., Vienna). Acta Phys. Austr.; 34: No. 1-2, 1-21 (1971).

Sequences of different Hilbert spaces are considered, and natural definitions are given for the convergence of sequences of elements as well as of closed operators taken from these different spaces. Theorems and criteria concerning the generalized strong operator convergence are shown. Finally the theory is applied to the physical problem of the infinite volume limit in quantum mechanics. Convergence in this sense is proven for most occurring Hamiltonians. (auth)

40193 ENTROPIC MECHANISM IN QUANTUM MEASUREMENTS. Majernik, Vladimir (Univ., Vienna). Acta Phys. Austr.; 34: No. 1-2, 83-92(1971).

The linkage between the measured quantum object and measuring macrophysical instrument during a measuring process is considered. The conditions for a one-to-one transformation of the quantum states of the measured microobject to the distinguishable macrophysical states of the measuring instrument in a quantum measurement are presented. Entropic processes in a measuring instrument during a quantum measurement caused by the interaction with a measured object generally supply a nonremovable noise in the measuring transfer channel, so that the assumption of the deterministical coordination of the pre-measurement states of a measured quantum object to the post-measurement states of a measuring instrument cannot be applied for a general quantum measurement. (auth)

40194 QUANTUM CORRECTIONS (WITHIN THE CLASSICAL PATH APPROXIMATION) TO THE BOLTZMANN DENSITY MATRIX. Hornstein, S. M.; Miller, W. H. (Univ. of California, Berkeley). Chem. Phys. Lett.; 13: No. 3, 298-300(1 Mar 1972).

A previously derived classical path approximation for diagonal matrix elements of the Boltzmann density matrix (i.e., the particle density) is expanded in a power series in $\hbar$ about the classical density. Comparing term by term with Wigner's expansion of the exact quantum mechanical density, one sees that the first quantum correction to the classical density (which involves first and second derivatives of the potential energy) is given correctly by the classical path approximation. Wigner's expression for the second correction term, however, involves the first four derivatives of the potential, and the classical path approximation gives only the part of this term that involves the first three derivatives. (auth)

40195 SCHROEDINGER EQUATION AND ITS SYMMETRY PROPERTIES. THE WIGNER THEOREM. Jancel, Raymond; Kahan, Theo (Institut Henri Poincare, Paris. CNRS, Paris). pp 1-26 of Group Theory in Classical and Quantum Physics. Vol. 3. /Kahan, Theo (ed.). Paris; Dunod (1972). (In French).

The symmetry properties of the nonrelativistic Schroedinger equation are studied. General theorems are established and the fundamental consequences relating to invariance, degeneracy and classification into states (Wigner theorem) are subsequently deduced. Applications to reducing the Hamiltonian are studied. (France)

REACTOR TECHNOLOGY

Power Reactor Development

40196 (EUR–4766) STATUS AND PERSPECTIVES OF HEAVY WATER MODERATED REACTORS AT THE END OF 1970. Decressin, A.; Haijtink, B.; Huber, B.; Orlowski, S. (European Communities, Brussels (Belgium). Commission). Feb 1972. 84p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 125,-.

The status of development, the technical potential and the economical perspectives of the different heavy-water variants are discussed in the frame of the nuclear market 1970 and its probable evolution. This frame reveals to be quite different from that existing 10 or 15 years ago. This difference explains largely the actual disaffection for this technically sound reactor concept. The evolution of the economical features until 1980 could eventually recreate a favorable frame for the competitiveness of heavy-water reactors. (75 references) (auth)

40197 (RDT-INDEX–5-72) INDEX OF RDT STANDARDS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 29p. RSO.

40198 NUCLEAR REACTOR. Lawrence, Barry Reginald (to United Kingdom Atomic Energy Authority). British Patent 1,272,296. 26 Apr 1972. Filed 29 May 1969.

Reference is made to liquid cooled reactors having a positive void coefficient, such as, for example, natural U fueled, light water cooled, heavy water moderated reactors. In such reactors a large and rapid increase in reactivity can be caused by accidental loss of coolant within the core, such as due to a breached coolant circuit. The volume of the core thus voided can be reduced by using several coolant circuits each serving a separate core sector, but the reactivity increase is not in direct proportion to the voided volume. In the system described the core is divided into groups of discrete elongated regions, the regions in each group being spaced from each other both azimuthally and radially relative to an axis of the core; each group is served by a separate coolant circuit. In the event of failure of a coolant circuit the reactivity increase is less than for a single voided core sector of equivalent volume. Provision can be made for coolant flow control to selected parts of the core when the reactor is operating normally, to effect spatial control or radial flux shaping during approach to burn-up equilibrium. In this case the core is preferably cylindrical and is divided into azimuthal sectors about its longitudinal axis, each sector containing one region of each group of regions, the regions of each group being disposed at progressively decreasing radii about the longitudinal axis. (UK)

40199 AEC AUTHORIZING LEGISLATION FISCAL YEAR 1973 PART 2. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, SECOND SESSION, ON CIVILIAN NUCLEAR POWER PROGRAM, FEBRUARY 22 AND 23, 1972. Washington, D. C.; Joint Committee on Atomic Energy (1972). 357p. GPO $1.50.

40200 NUCLEAR REACTORS. Shaw, James William Westgarth (to United Kingdom Atomic Energy Authority). British Patent 1,273,737. 10 May 1972. Filed 14 Aug 1968.

Reference is made to reactors having a moderating core structure cooled by a coolant flow in the opposite direction to the flow over the fuel element channels. In the arrangement described the moderating core structure is supported from the base of the concrete pressure vessel by a number of tubular pillars, and a plenum is formed bounded by the lower end of the core structure and the pressure vessel; a second plenum is formed bounded by the upper end of the core structure and the pressure vessel. The first plenum has a horizontal membrane dividing it into upper and lower sections, the upper section having a coolant outlet duct extending through the pressure vessel wall and the lower section a coolant inlet duct also extending through the pressure vessel wall. The vertical fuel element channels communicate with the second plenum and the upper section of the first plenum, and a number of interstitial channels in the core structure communicate with the second plenum and the tubular pillars, the walls of which have parts disposed within the lower section of the first plenum; radial passages in the moderator structure give communication between the lower ends of the interstitial channels and the lower ends of neighboring fuel element channels. Fuel element assemblies in the fuel element channels may be provided with continuous sleeves that cooperate with the walls of the fuel element channels to form annular passages closed at their lower ends and communicating with the upper end of the second plenum being arranged so that coolant flow through the pillars is divided into fractions passing through the interstitial channels, the radial passages and the annular passages to the second plenum, coolant flow being then by way of the fuel element sleeves to the upper section of the first plenum. The mode of operation is described in detail. Provision is made for cooling a neutron shield surrounding the core. (UK)

40201 CHANCES OF INTERNATIONAL COLLABORATION IN THE NUCLEAR ENERGY FIELD. Mandel, Heinrich (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). Elektrizitaetswirtschaft; 70: No. 17, 498-507(1971). (In German). (CONF-710546–1).

From Annual meeting of VDEW; Mainz, Germany (25 May 1971).

A summary description is given of the nuclear power plant market, followed by an estimation of costs of the development of high-temperature reactors and fast breeder reactors. A consideration of the cost factors of the manufacturing of the most important nuclear power plant components and the fuel cycle indicates possible ways of an international industrial cooperation. (INIS)

40202 CURRENT STATUS OF DEVELOPMENT ON FAST BREEDER REACTOR TECHNOLOGY. Fast Breeder Reactors Conference, Tokyo, Japan, February 18, 1970. Tokyo; Atomic Energy Society of Japan (1970). 90p. (In Japanese). (CONF-700229).

The Study Committee on Fast Reactors was started in the Atomic Energy Society of Japan for the term of two years from October 1968. The panel meetings held by the committee are described in the form of individual reports: instrumentation and control for fast reactors, safety design of fast reactors, fuel pins evaluation at high burn-up, the state of nuclear-physics designs and the problems in the development of fast reactor plants. (Japan)

Physics and Core Engineering

40203 (ANL–7926) ACTIVATION-RATE MEASUREMENTS IN THE ZPR-3 MOCKUP CRITICAL EXPERIMENTS. PART II. MEASUREMENTS OF FOIL-ACTIVATION RATES IN ASSEMBLY 61 OF ZPR-3 MOCKUP OF EBR-II WITH A NICKEL REFLECTOR. Heinrich, R. R.; Dudey, N. D.; Popek, R. J.; Larsen, R. P.; Oldham, R. D. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 52p. Dep. NTIS.

Activation-rate measurements conducted in the ZPR-3 critical facility in mockup experiments designed to simulate various configurations of EBR-II are discussed. The primary objective is to describe these measurements and to present the data in a useful form. The activation-rate measurements conducted in Assembly 61 of ZPR-3 are examined. The study consisted of two experiments. The first experiment was designed to provide activation-rate data for dosimetry purposes, i.e., data for characterizing the irradiation environment in terms of reaction rates, neutron flux and neutron spectrum, and for defining the effects of heterogeneity within the assembly. The second experiment was designed to provide data from which fast-neutron fission yields of several short- to intermediate-lived fission products could be established. The measurements were made using a Ge(Li) detector and solid-state fission-track recorder. Both experiments involved irradiations of foils near the center of the reactor core, near the core-reflector interface, and within the nickel radial reflector, which in Assembly 61 replaced the uranium blanket of Assembly 60. The data on fission yields and reaction rates are presented, intercompared, and also compared with the results from another activation-rate experiment conducted by an independent group. 13 references. (auth)

40204 METHOD FOR VERIFYING REACTIVITY-FEEDBACK TIME RESPONSE IN POWER REACTORS. Fry, D. N. Nucl. Safety; 13: No. 4, 295-300(Jul-Aug 1972).

A method is presented for on-line monitoring of the reactivity-feedback time constants for determining the operating stability of large fast breeder reactors. In this method, monitoring can be performed without interfering with normal reactor operation, with negligible reactor power disturbance, and without the need for special in-core reactivity oscillators. The method also is conducive to the detection of partial flow blockages in coolant channels in reactor core subassemblies. (9 references) (auth)

40205 BLANKET SHAPE OPTIMIZATION IN BREEDER REACTORS. Spitzer, Josef Egon. Albuquerque, N. Mex.; Univ. of New Mexico (1971). 120p. University Microfilms Order No. 72-13,801.

Thesis.

Current breeder reactor designs involve the use of constant thickness blankets. Vertical cross-sections of these designs display rectangular blanket shapes. It is evident that the "corners" of these rectangular blankets are inefficient in their production of plutonium relative to the mass of fertile material contained therein. A method of designing the shape of a blanket to make optimum use of its fertile inventory and the effects of an optimal blanket on the fuel cycle cost of a breeder reactor are presented. (Diss. Abstr. Int., B)

40206 NUCLEAR PROPERTIES OF Pu RECYCLING IN BOILING WATER REACTOR. Fukai, Y. (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Japan). Genshiryoku Kogyo; 17: No. 12, 19-23(Dec 1971). (In Japanese).

When Pu fuel is used for BWRs, general practice is to replace a part of U fuel with the Pu fuel. In this case, it is only necessary to alter the plants in part. Problems of mismatch with U assemblies in power distribution arise, however. The difference in nuclear characteristics between the two types of fuel is first described: initial reactivity and fuel burn-up, control-rod equivalent reactivity, void coefficient, Doppler coefficient, and peaking factor. Then, concerning Pu content in Pu assemblies and Pu-assembly fueling, the following procedure is explained: (1) determination of degree of Pu enrichment, so as to give similar burnup to the U fuel; (2) Pu-enrichment distribution, to give the same peaking factor as that in the U fuel; and (3) adjustment in Pu power output to be proper for that of the U fuel adjoining it. (Japan)

40207 NUCLEAR PROPERTIES OF Pu RECYCLING IN PRESSURIZED WATER REACTOR. Nakano, Y. (Mitsubishi Atomic Power Industries, Inc., Tokyo). Genshiryoku Kogyo; 17: No. 12, 24-9(Dec 1971). (In Japanese).

Economy in recycling Pu fuel in PWRs and also nuclear characteristics of plutonium are reviewed. Current practice in the Pu recycling in PWRs is to follow U core design, attempting to maximize the Pu-recycle utilization; it is then also required to replace readily U with Pu, or vice versa, at any recycling point. In recycling Pu fuel in PWR plants, existing nuclear characteristics of the reactor plants must be retained as far as possible. In this connection, the following are described: burn-up characteristics, power distribution in reactor core, reactivity control in the reactor core, and dynamic characteristics of the PWRs. Discussion on the Pu recycle design in the PWRs is made on the basis of capture to fission ratio, neutron generation per fission of Pu isotopes, etc. (Japan)

40208 SUBCHANNEL THERMAL ANALYSIS OF ROD BUNDLE CORES. Chelemer, H.; Weisman, J.; Tong, L. S. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Des.; 21: No. 1, 35-45 (1972).

The subchannel analysis substantially revises the concept of engineering hot-channel factors. Previous design techniques sequentially applied hot-channel factors to the core average enthalpy rise and flow in an attempt to estimate the flow and enthalpy rise in the hottest subchannel of the core. A three-dimensional matrix is used to represent the core. Coolant conditions within each matrix element are determined by simultaneous solution of the equations of conservation of mass, energy, and momentum. The behavior of the hot assembly is determined by superimposing the power distribution among the assemblies upon the flow distribution while allowing for flow mixing between assemblies. Another three-dimensional matrix is used to represent the subchannels within the hot assembly. Coolant conditions are obtained from solution of the continuity equations for each matrix element. The flows to and from the hot assembly, computed by the core-wide analysis, are used as a boundary condition. The local variations in power, fuel rod and pellet dimensions, and mixing within the assembly, are superimposed in these calculations in order to determine the conditions in the hot subchannel. The procedure avoids the repetitive application of penalty factors inherent in the use of the simple product of all hot-channel factors. 18 references. (auth)

Control and Instrumentation

Refer also to abstracts 38438 and 38555.

40209 (RDT-C-16-2-T(4-72)) PROTECTION SYSTEM LOGIC. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 23p. RSO.

The requirements covering mechanical and electrical design, material procurement, fabrication, testing, inspection, cleaning, packaging and shipping for a Plant Protection System (PPS) and required documents are established. The Protective Logic supplied consists of all equipment necessary for processing the Comparator output signals to initiate a reactor scram or other protective action based on a specific combination of the input signals provided to the Protective Logic by the Comparators. The equipment includes PPS Logic, associated power supplies, mechanical mounting hardware, and interconnecting wiring hardware. (auth)

40210 (RDT-C-16-4-T(4-72)) PROTECTION SYSTEM COMPARATOR. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 31p. RSO.

The technical, functional, and administrative requirements covering mechanical and electrical design, material procurement, fabrication, testing, inspection, cleaning, packaging and shipping for Plant Protection System (PPS) Comparator and required documents are established. The Comparator consists of all equipment necessary for processing the analog instrumentation output signals to provide trip signals and reset signals to the Protective Logic based on the relationship between the analog instrumentation signal and a setpoint. The equipment includes PPS Comparators, associated power supplies, mechanical mounting hardware, and interconnecting wiring hardware. (auth)

40211 NUCLEAR REACTOR CONTROL SYSTEM. Bailey, Herbert S. Jr.; Stewart, Samuel L. (to General Electric Co.). U. S. Patent 3,660,230. 2 May 1972. Filed 26 Nov 1968.

A nuclear reactor control system is described in which reactivity in the core is controlled by neutron absorbing material which is moved into and out of the fuel containing core region. Neutron moderating material is included in followers connected to the neutron absorbing control elements so that the moderating material is brought into the core fuel region when the neutron absorbing material is removed therefrom. This system is especially applicable to a reactor of the fast neutron breeder type. The use of moderating material in a fast reactor core improves the inherent safety characteristics of the core by improving the Doppler reactivity effect and coolant voiding reactivity. The incorporation of the moderating material in control material followers results in improvement in core fissile requirements, breeding ratio and core conversion ratio. (Official Gazette)

Containment Systems, Waste Processing, and Radiation Protection

40212 (K-L-6288) APPLICATION OF THE SELECTIVE ABSORPTION PROCESS TO THE REMOVAL OF KRYPTON AND XENON FROM REACTOR OFF-GAS. Stephenson, M. J.; Merriman, J. R.; Dunthorn, D. I. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 14 Feb 1972. Contract W-7405-eng-26. 11p. Dep. NTIS.

Reduction of noble gas activity in reactor effluents involves handling gas streams having low molar concentrations of Kr and Xe. One potential gas cleaning technique suitable for reactor application is the selective absorption process. Tests were recently completed to provide experimental verification of process performance at expected reactor conditions. In these tests, radioactive Kr and Xe isotopes were used to prepare simulated reactor off-gases having Kr concentrations ranging from about 10 ppB to 4 ppM and Xe contents between about 3 ppB and 15 ppB. In addition to air, N_2, Ar, He, and H_2 were utilized as carrier gases. Overall process Kr and Xe removals as high as 99.9 and 99.99%, respectively, were measured. The data indicated that high Kr removals at low feed concentrations are readily attainable and that previous performance correlations based on high concentration experiments are valid when applied to low level cases. Also, Xe removal was found to be very good, and no problems were encountered in stripping the dissolved Xe from the solvent. Efficient removal of Kr from carrier gases other than air was demonstrated, and predictable variations in the potential for concentrating the product gas were observed as the carrier gas was changed. (auth)

40213 (RDT-E-11-1-T(5-72)) ION EXCHANGER, NON-REGENERATIVE TYPE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). May 1972. 22p. RSO.

The standard contains requirements covering the construction and acceptance of radioactive waste system ion exchangers, non-regenerative type, and all required accessories and appurtenances. Ion exchangers covered are to be used in radioactive auxiliary systems of a pressurized water nuclear plant. Included are ion exchangers used in the following services: (a) Clean up units which will process reactor coolant for removal of corrosion and fission products as required for safe disposal of the coolant. (b) Polishing units which will be used for final clean up of radioactive water prior to discharge from the plant. (auth)

40214 PROBLEME DES BAUTECHNISCHEN STRAHLENSCHUTZES. V. .Vortraege Gehalten auf einer Sitzung des

Fachausschusses Strahlenschultz, Berlin, 21./22. April 1970. (Problems in Construction of Radiation Protection. V. Reports Presented at a Meeting on Radiation Protection, Berlin, April 21–22, 1970). Schultz, H. (ed.). Kernenergie-Studiengesellschaft, No. 20. Munich; Verlag Karl Thiemig KG (1971). 50p. DM 9.80. (CONF-700450).

This collection of six papers presents the results of both theoretical and experimental work on shielding. Shielding calculations using the UNC-SAM system in the Monte-Carlo program, and calculations for optimizing reactor shielding are described. Other papers discuss sodium coolant piping along neutron beams, discharge spectra for gas-cooled reactors, and the theory of beam tubes in cylindrical geometry. (K.S.W.)

Coolant System

Refer also to abstracts 38380, 38546, and 38988.

40215 (ORNL-TM-3845) HIGH-TEMPERATURE STRUCTURAL DESIGN METHODS FOR LMFBR COMPONENTS. Quarterly Progress Report for Period Ending March 31, 1972. Greenstreet, W. L.; Corum, J. M.; Pugh, C. E. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 144p. Dep. NTIS.

The ORNL program to develop high-temperature structural design methods for LMFBR vessels, components, and core structures is described. Effects of temperature on the tensile properties of Type 304 stainless steel are measured. 46 references. (auth)

40216 (RD/B/N–1630) RADIAL DISTRIBUTION OF BUBBLES IN SODIUM FLOWING THROUGH HEATED CHANNELS. Holland, P. K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1970. 11p. Dep. NTIS (U. S. Sales Only).

Expressions are obtained for the forces on small bubbles in heated turbulent flows. These expressions show that argon bubbles in the sodium coolant flow through a fast reactor core will be concentrated near the fuel pins. (12 references) (auth)

40217 (RD/B/N–2259) NEW METHOD OF CONTINUOUSLY MONITORING THE VOID FRACTION OF FLOWING SODIUM. Hayes, D. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1972. 16p. (CFR/EST/P–(72)78). Dep. NTIS (U. S. Sales Only).

A new method of continuously monitoring the void fraction of flowing sodium is described. It consists of applying an oscillating pressure to the sodium and measuring the amplitude of the induced velocity fluctuations. The oscillating pressure is generated with an AC conduction pump, and the flow oscillations are measured with an electromagnetic flowmeter. A simple theory is presented which shows that the void fraction may be calculated directly from the observed amplitude of flow oscillations if the pressure developed by the pump is known. The method should be applicable to a wide range of void fractions. By means of the published values for compressibility a direct calibration of the method is possible with gasfree sodium: The method should be capable of a sensitivity of $\sim 10^{-6}$. Experiments were carried out on a sodium loop which had most of the desirable features for monitoring void fractions in the manner described. A calibration factor was obtained using vacuum-outgassed sodium. The observed void fractions ranged from $<1 \times 10^{-5}$ for vacuum-outgassed sodium to 6×10^{-4} for sodium known to contain gas. (auth)

40218 (RDT-E-6-9-T(4-72)) CORE SUPPORT STRUCTURE FOR PRESSURIZED WATER REACTORS (FABRICATION ONLY). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 13p. RSO.

The requirements for fabrication, quality assurance and preparation for delivery of core support structure components for pressurized water reactors are presented. (auth)

40219 (RT/ING–(71)21) EXPERIMENTS RELATIVE TO THE THERMOHYDRAULICS OF SODIUM-COOLED FAST REACTORS. Iannuzzo, P.; Pezzilli, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Dec 1971. 24p. (In Italian). (CONF-710952–3). Dep. NTIS (U. S. Sales Only).

From Symposium of the Italian Thermotechnical Association; l'Aquila, Italy (21 Sep 1971).

After analyzing the fundamental characteristics of sodium as heat exchanger fluid, some considerations are made on the thermohydraulics of sodium cooled fuel elements and some problems are examined concerning their simulation with out-of-pile experiments on the base of established performances and fuel elements geometries. The considerations are extended to the problem of fast reactors safety. The accidental situations that can bring coolant boiling are emphasized and some of the most important results obtained in experiments are discussed. (10 references) (auth)

40220 SELECTING A SUITABLE TYPE OF MAIN CIRCULATION PUMP IN A NUCLEAR POWER STATION WITH A REACTOR COOLED BY WATER UNDER PRESSURE. Turetskii, L. I.; Gryzlov, A. G.; Pugacheva, T. F.; Puzyrev, L. K. Therm. Eng. (USSR) (Engl. Transl.); 17: No. 12, 4-7(1970).

Translated from Teploenergetika; 17: No. 12, 8-10(1970).

The characteristics needed in high capacity main circulation pumps for water cooled reactors are examined. The most suitable pumps are determined to be axial flow units with a shaft speed of 3000 rpm. Such pumps use hydrodynamic shaft seals and radial-thrust ball bearings and are smaller, lighter, and cheaper than centrifugal pumps. (H.D.R.)

40221 STEAM COOLED NUCLEAR REACTOR. Fox, Jack N.; Hansen, Ned P.; Olich, Eugene E.; Guenther, Ralph W.; Rubinstein, Herbert J. (to General Electric Co.). U. S. Patent 3,660,231. 2 May 1972. Filed 26 Nov 1968.

A nuclear reactor pressure vessel internals arrangement including a core assembly, control means and steam flow directing means is disclosed. The reactor utilizes a two-pass steam flow scheme in which steam flows downwardly through nonfueled core components and then flows upwardly through the fuel assemblies. The reactor internals are located within a shroud which forms a second pressure-tight vessel. Water located in an annular space between the internal shroud and the main pressure vessel provides additional shielding and is readily available for core flooding. The arrangement provides improved safety, simplicity and reliability in steam cooled reactor operation. (Official Gazette)

Fuels and Fuel Elements

40222 (ANL–7880) METHOD FOR CALCULATING DISTRIBUTIONS OF FLUX, POWER, AND BURNUP IN OXIDE SUBASSEMBLIES IRRADIATED IN EBR-II. Golden, G. H.; Miller, L. B. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 43p. Dep. NTIS.

A method for calculating the axial distributions of flux, power, and burnup in LMFBR mixed-oxide fuel elements irradiated in EBR-II was developed. Peak absolute fluxes and fission densities for ^{235}U, ^{238}U, ^{239}Pu, and ^{240}Pu are obtained from transport-theory calculations in X–Y geometry for specific run configurations in EBR-II. These calculations display global and local variations in flux in the reactor. Relative axial distributions are obtained from transport-theory calculations in R–Z geometry. A procedure for accounting for burnup of the heavy nuclides is given. The effective MeV/fission to be used to convert rate of total fission to power is calculated for a subassembly of 19 mixed-oxide elements in row 4 and a subassembly of 37 mixed-oxide elements in row 5 of EBR-II. The elements studied were C17 and C1 in subassemblies X012 and X012A, and F3B3 and 011 in subassembly X040A. (14 references) (auth)

40223 (BAW–10044) TAFY: FUEL PIN TEMPERATURE AND GAS PRESSURE ANALYSIS. Morgan, C. D.; Kao, H. S. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Apr 1972. 44p.

The TAFY computer code is used in determining temperature and internal pressure buildup of fuel pins during the lifetime of the fuel. The code determines the effects of temperature distribution, fuel-cladding thermal interfaces, fuel-cladding dimensional changes, internal pressure, and the like. A comparison of data from the literature and experimental data obtained with the TAFY code indicates that TAFY provides an accurate and conservative prediction of fuel pin temperatures and pressures. (24 references) (auth)

40224 (GEAP–10028-40) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Fortieth Quarterly Report, August–October 1971. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Nov 1971. Contract AT(04-3)-189. 174p. Dep. NTIS.

FAST CERAMIC REACTOR—fuel elements for, development during August to October 1971
—core for, design and kinetics analysis of
—safety of, transient overpower and loss of flow effects on
HASTELLOY X—radiation effects on swelling and mechanical properties of, fast neutron, (E)
INCOLOY 800—radiation effects on swelling and mechanical properties of, fast neutron, (E)
INCONEL 625—radiation effects on swelling and mechanical properties of, fast neutron, (E)

LIQUID METAL FAST BREEDER REACTOR—fuel elements for, development of stainless steel clad plutonium oxide (PuO_2)–uranium oxide (UO_2)
NEUTRONS, FAST—effects on Hastelloy X, Incoloy 800, Inconel 625, and stainless steels, (E)
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects testing of fuels of
—PuO_2–UO_2, properties of fuels of, mechanical, physical, and thermal, (E)
REACTOR FUEL ELEMENTS—performance of defected uranium oxide (UO_2)–plutonium oxide (PuO_2), in flowing sodium, (E)
—cladding for uranium oxide (UO_2)–plutonium oxide (PuO_2) fast, development and testing of stainless steel
—radiation effects testing of uranium oxide (UO_2)–plutonium oxide (PuO_2) fast
STAINLESS STEEL—radiation effects on swelling and mechanical properties of Type 304, Type 316, and Type 321, fast neutron, (E)
URANIUM OXIDES UO_2—PuO_2–UO_2, radiation effects testing of fuels of
—PuO_2–UO_2, properties of fuels of, mechanical, physical, and thermal, (E) (D.C.C.)

40225 (GEAP–13760) SEFOR FUEL ROD FABRICATION, 1967–1968. Johnson, M. L.; Lannin, T. E.; Pflasterer, G. R.; Wallace, R. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Jan 1972. Contract AT(04-3)-540. 372p. Dep. NTIS.

The fabrication of fuel rods which were procured for the initial core of the Southwest Experimental Fast Oxide Reactor (SEFOR) is described. Fabrication of 756 standard PuO_2–UO_2 fuel rods, 18 guinea pig rods having increased fissile material enrichment and 245 loose fuel pellets was contracted. The product was delivered to the reactor site in the calendar year 1968. Several significant problems were encountered during production or uncovered during subsequent quality control inspections. Among these were oxygen-to-metal ratio, high volatile content, low plutonium content in redissolved pellet scrap, porosity of end plug materials and control of welding parameters. These problems resulted in a high reject and rework rate. However, the accepted rods that were loaded into the full-power reactor core have operated with no known leaks, cladding deformation or other defects or damage during reactor operation to date, which includes operation at the design power level of 20 megawatts and transient tests. (auth)

40226 (PNCT–831-71-1) TOKAI WORKS SEMIANNUAL PROGRESS REPORT, JULY–DECEMBER 1970. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Sep 1971. 82p. Dep. NTIS (U. S. Sales Only).

The fabrication and testing programs for stainless steel clad PuO_2–UO_2 fuel rods for fast reactors are reviewed. The radiation testing of PuO_2–UO_2 fuel rods is analyzed. Reprocessing methods for PuO_2–UO_2 fuels are studied. (D.C.C.)

40227 MIXED-OXIDE FUEL IRRADIATIONS IN THE PLUTONIUM RECYCLE TEST REACTOR. Freshley, M. D. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 15: No. 4, 125-76 (Aug 1972).

The satisfactory irradiation performance of several types of mixed-oxide fuels suitable for the utilization of plutonium in thermal reactors was demonstrated by a significant number of experiments performed in PRTR. Heterogeneously and homogeneously enriched packed-particle and pellet mixed-oxide fuels were irradiated at peak linear heat ratings higher, i.e., >655 W/cm(>20 kW/ft), than those employed in the most advanced commercial reactors to significant burnups, i.e., >18,000 MWd/MTM. Early experience in PRTR provided some of the first data related to the effects of hydrogeneous impurities on Zircaloy clad mixed-oxide fuel performance. The demonstrated solution to the problem was achieved through the development of improved analytical and fuel fabrication techniques. Fuel rod cladding becomes oval shaped during irradiation due to creep collapse with the degree of ovality varying among the different fuel types. The fission gas release fraction for vipac mixed-oxide fuels varies linearly from a value of 0.05 for a volumetric average temperature of 600° to essentially 1.00 for a volumetric average temperature of 2250°C. Homogenization of the PuO_2 particles in mechanically-mixed UO_2–PuO_2 commences at fuel temperatures sufficient to cause sintering and equiaxed grain formation during irradiation. PRTR experience indicates that a fuel/clad reaction that is stoichiometry dependent occurs in Zircaloy-clad mixed-oxide fuels. The satisfactory defect performance of mixed-oxide fuels was demonstrated by several in-service and intentionally defected experiments although there are indications that defect performance may constitute an operating limit at very high linear heat ratings. (61 references) (auth)

40228 DEFECT PERFORMANCE OF UO_2–PuO_2 THERMAL REACTOR FUEL. Freshley, M. D. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 15: No. 4, 209-28(Aug 1972).

The defect performance of Zircaloy-clad mixed-oxide fuel operating in a pressurized-water environment was studied from the standpoint of fission product activity release to the coolant and the effects of a defect on fuel behavior. The defect experiment described was conducted over a range of linear heat rating conditions including those which resulted in fuel melting to investigate the effects of different operating parameters. The results show that the activity release characteristics of the fuel rod are sensitive to the operating mode and that the major species released to the coolant are the fission product gases, iodine, the alkali metals, and tellurium. There were no localized dimensional perturbations associated with the cladding in the defect region although the ingress of steam vapor into the rod resulted in oxidation of the mixed-oxide fuel. Comparison of fuel structures formed in the defected and a companion nondefected rod indicates that within the experimental uncertainties associated with this experiment, the effect of defecting on the melting heat rating is less than 10 percent and possibly insignificant. An oxygen-rich atmosphere in the interior of the fuel rod during irradiation prevented massive hydriding of the cladding. (35 references) (auth)

40229 POSSIBLE APPLICATIONS OF THE ENERGY GAMMA SCAN FOR DETERMINING THE POWER AND CONSUMPTION PROFILES IN LIGHT-WATER FUEL ELEMENTS. Trinkl, Anton; Wuertz, Ruediger (Kernenergieversuchsanlage, Grosswelzheim, Ger.). At. Strom; 18: No. 3-4, 67-9(Mar-Apr 1972). (In German).

The recording of axial and azimuthal energy gamma scans on fuel elements and radial scans on fuel sectional testpieces with a semiconductor detector makes it possible to provide definite data on the relative power distribution achieved in a fuel element. It is also possible, by using selected fission products, to determine the power distribution over different radiation periods. In addition, the variation of the power obtained in the fuel elements, and which originates in the plutonium which is bred, can also be stated. The methods of measurement required are described. (auth)

40230 FAST NEUTRONIC REACTOR UTILIZING ^{240}Pu FUEL. Connolly, Thomas J. U. S. Patent 3,664,923. 23 May 1972. Filed 11 Sep 1968.

A fast neutron fission chain reactor utilizes plutonium enriched in the isotope plutonium-240 as its principal fuel. A novel reactor concept employs a core comprising a critical mass of the subject isotope in combination with other isotopes, together with specially adapted control, safety, and related devices. (Official Gazette)

40231 THERMAL, RADIATION, AND MECHANICAL ANALYSIS FOR UNSTEADY-STATE FUEL RESTRUCTURING OF CYLINDRICAL OXIDE ELEMENTS IN FAST REACTORS. Cheng, C. K.; Ma, B. M. (Iowa State Univ., Ames). Nucl. Sci. Eng.; 48: No. 2, 139-58(Jun 1972).

The time-dependent radius of the central void and the extents of the columnar grain, the equiaxed grain, and the unaffected grain regions of a typical oxide cylindrical fuel rod in a fast reactor at constant power level are determined. The temperature distributions in the fuel element are obtained. A model postulated to analyze and calculate the irradiation swelling and fission-gas release for oxide fuels of fast reactors is developed. The mechanical analysis is based on the thermal and radiation dilatations and on an elastoplastic approach for the Prandtl–Reuss material. An iteration method of successive approximation is used to compute the stresses and strains developed in the fuel elements. The computed results are shown by curves for the unsteady-state fuel restructuring of the fuel element. 34 references. (auth)

40232 EFFECT OF RANDOM DISPOSITON OF MATERIAL UPON THE TEMPERATURE DISTRIBUTION IN A FUEL ELEMENT. Barrett, P. R. (Univ. of New South Wales, Kensington). Nucl. Eng. Des.; 21: No. 1, 72-84(1972).

For a fuel element containing two material phases, the discontinuous phase being randomly dispersed within the continuous phase, equations are derived for the mean and variance of the temperature distribution. The statistical model is restricted to only small individual volumes of the second phase material and is thus applicable to the treatment of the effect of fission gas filled pores and to small granules of one type of fuel embedded randomly in the overall continuous fuel material matrix. Modifications of the theory to account in a simple fashion for strong temperature-dependent thermal conductivities (for example, the effective thermal conductivity of gas-filled pores) are discussed. It is shown by examination of the variance to mean ratio of the temperature drop from the center to the outer surface of a fuel rod that this represents a significant statistical effect, particularly for the case of gaseous pores in fast reactor UC fuel rods. (auth)

40233 BEHAVIOR OF GAS BUBBLES IN THE SODIUM-BONDED, CARBIDE-FILLED FUEL RODS OF A FAST BREEDER. Schoeneberg, R.; Ernst, H. (AEG-Telefunken, Grosswelzheim, Ger.). Nucl. Eng. Des.; 21: No. 1, 65-71(1972). (In German).

The present fuel element concept of the high gain breeder provides a sodium bond between fuel and cladding. A sodium bond seems to be indispensable in view of the high swelling rate and the high linear rod power, but it also implies the danger of its loss during abnormal operating conditions. The consequences of stagnant fission gas bubbles and the growth of sodium-vapor bubbles within the bond during external disturbances are examined. Computer programs, describing the time behavior of the sodium evaporation and the bubble expansion have been developed which led to the definition of a critical bubble size. Bubbles larger than the critical one give rise to the loss of the bond even at small external disturbances. Furthermore the calculations show that after partial blockage of a fuel element the bond is lost very quickly (within 0.4 sec) even with initial bubbles being subcritical. This result is related to the present core design using fuel venting at the upper part of the rods. A new rod concept is discussed which delays the bubble expansion process in the bond up to time intervals which allow the safe detection of this event even with thermocouples at the upper part of the fuel element. (auth)

Auxiliary Systems and Engineered Safeguards

40234 ADVANTAGES OF PRIMARY SYSTEM FLOW CONTROL DURING REACTOR SCRAM IN AN LMFBR. Metevia, William J.; Gilbertson, Jon C. (Combustion Engineering, Inc., Windsor, Conn.). Nucl. Technol.; 15: No. 3, 93-8(Jul 1972).

Following a reactor scram in an LMFBR, the sodium flow rate through the core should ideally be reduced at such a rate as to hold the core Δt essentially constant if thermal stresses are to be minimized. Three different methods of varying primary coolant flow following scram were investigated. These include: (a) a normal pump coastdown; (b) a braking force applied to the primary pump; and (c) a fast-closing throttle valve in the primary coolant circuit. It was determined that proper action of a primary system throttle valve can eliminate severe thermal shocks to the core following scram and pump trip out. A pump brake will reduce, but not eliminate, the excessive stresses generated in the upper core region following reactor scram and free rotating pump coastdown. (auth)

Operation and Economics

40235 (WASH-1184) COST-BENEFIT ANALYSIS OF THE U.S. BREEDER REACTOR PROGRAM. Updated (1970). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 56p. Dep. GPO $0.65.

Seven groups of calculations consisting of 16 cases are presented. The calculations indicate the benefits accrued from an economy with a breeder as compared to an economy with only fossil, light water reactor (LWR), and high temperature gas reactor (HTGR) power plants. By varying the input data, the effects of potential situations and the sensitivity of the results to the assumptions were investigated. The characteristics of the seven groups are presented. Each group consists of a base case without a breeder and cases with a breeder represented by the LMFBR. The cases with the breeder indicate that the required energy could be produced less expensively than the corresponding case without the breeder and the difference represents the dollar benefit of the breeder. The seven groups were designed to determine the effect of varying the date of introduction of the breeder, varying uranium resources, varying energy demand, increasing the capital cost of the breeder, and the ability of the HTGR to penetrate the market. (auth)

40236 RECYCLING OF PLUTONIUM IN THERMAL REACTORS. Maerkl, H. (Siemens AG., Erlangen, Ger.); Stoll, W. Atomwirt., Atomtech.; 17: No. 6, 306-12(Jun 1972). (In German).

Until the time when fast breeder reactors find large scale application, countries with nuclear power plants will experience an annually growing Pu excess. Economical use of the Pu before availability of fast breeders will be utilization in thermal reactors. Two possibilities must be distinguished; Pu utilization in the producing plant and Pu use in special light water reactors. During the next six to eight years, in West Germany, Pu will be recycled in the reactors from which it was produced. Only toward the end of the seventies will the excess become so large that special reactors with pure-Pu cores become feasible. (tr-auth)

40237 NUCLEAR REACTOR PERFORMANCE AND FUEL MANAGEMENT SIMULATOR FOR POWER SYSTEM PLANNING ACTIVITIES. Henderson, Ronald Royce. Columbus, Ohio; Ohio State Univ. (1971). 177p. University Microfilms Order No. 72-15,222.

Thesis.

The peculiar problems associated with the effective integration of nuclear power stations into system planning models present a need for the development of a simplified nuclear scoping model. The main aspects of the nuclear fuel management problem must be incorporated into the model to consider the available flexibility of the nuclear units in establishing system operating and maintenance schedules and in determining replacement fuel requirements and delivery schedules in response to power system requirements. The model must determine batch sizes, enrichments, and energy outputs while insuring operation within established operational constraints. The model accepts as input a reactor operating and energy production schedule, and determines the feasibility of the unit meeting this schedule and the unit energy costs for each cycle and the levelized energy cost over the scheduled period. The components of the nuclear model were incorporated into an integrated nuclear model and were initially tested in analyzing reactor energy production and refueling schedules. This initial application indicated a high sensitivity to the cost parameters selected for the planning period. The model was extended to incorporate an exhaustive search over a range of external refueling alternatives which satisfy the prescribed energy production schedule. This model was very sensitive to the established one-dimensional power distribution constraint, indicating the need for care in the selection of an appropriate value for the power distribution constraint. The general utility of the nuclear reactor performance and fuel managment simulator for its intended purpose as a nuclear scoping model for power system planning activities was verified. (Diss. Abstr. Int., B)

40238 NUCBID: A COMPREHENSIVE NUCLEAR FUEL ECONOMICS CODE FOR UTILITY APPLICATIONS. Hoskins, Raymond E.; Cooper, Eleanor G.; Belitz, James G. IEEE (Inst. Elec. Electron. Eng.), Trans. Power App. Syst.; PAS91: No. 1, 46-53(Jan-Feb 1972).

A basic unit energy cost algorithm for nuclear fuel is presented which adheres to engineering economic principles permitting precise treatment of time dependent cash and energy flow considerations. A comprehensive computer program, NUCBID, developed by TVA based on the algorithm is described. The program was developed primarily to perform bid evaluations and is suitable for financial and procurement planning as well as documentation of evaluations. The program has a high degree of flexibility; (1) a wide variety of fuel cycles, fuel supply scopes, and pricing alternatives can be treated, (2) details of various fuel management schemes can be represented, (3) terms of payment and price adjustment provisions can be treated accurately, and (4) a minimum of manual data preparation is required. A simulated operation of the nuclear unit is performed to develop an operating history which is used to compute a detailed cash flow and unit energy cost for each fuel batch. Time dependent unit energy costs are calculated. Then a month by month accounting procedure is performed to produce chronological cash flows, discounted cash flows, production cost allocations, fuel cycle inventory values, and levelized fuel cost on an electrical and/or thermal energy basis. (auth)

40239 ENERGY FROM BREEDER REACTORS. Culler, Floyd L. Jr.; Harms, William O. (Oak Ridge National Lab., Tenn.). Phys. Today; 25: No. 5, 28-35; 37; 39(May 1972).

Estimates of the electric power demand in the U. S. for the next 50 years are discussed. Breeder reactors are projected to be an essential source of supply to meet these power demands. The technology and economics of existing and planned fission reactors are considered, and some of the limitations of breeders are examined. 19 references. (H.D.R.)

40240 PLUTONIUM RECYCLE IN LIGHT WATER REACTORS. Nakamura, Yasuji (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 12, 5-8(Dec 1971). (In Japanese).

Introduction of plutonium fuel into light-water reactors in the form of spent-fuel recycle is becoming practical reality. Its basic technology is near perfection and is expected to be practical in early 1970s. World trend in the light-water reactors, in association with the plutonium recycle, is first reviewed. Then, plutonium credit and plutonium cost in fuel cycle, cost problem of plutonium storage, and plutonium disintegration are described. With reference to cost of uranium enrichment, economic aspects are detailed on enrichment of spent uranium, the recycle of recovered plutonium, and of both fuels for reactor refueling. Finally, in the plutonium-fuel producing plant, the problem of radiation protection as an economic factor is explained. (Japan)

40241 PLUTONIUM RECYCLING DEMONSTRATION IN THE WORLD. Fujii, H. (Kansai Electric Power Co. Inc., Osaka). Genshiryoku Kogyo; 17: No. 12, 9-14(Dec 1971). (In Japanese).
An outline and features of plutonium recycling demonstrations in the world are described in the panel discussion on thermal neutron power reactors held in June 1971 at IAEA, Vienna. The following matters are reported: BR-3 and SENA in Belgium; Dodewaard reactor in the Netherlands; Kahl and KWO in West Germany; Garigliano in Italy; Big Rock Point, Vermont Yankee, San Onofre, and Dresden-1 in U. S.; and JPDR-II and Mihama-1 in Japan. Plutonium recycling status has already proceeded to the stage possible to practice commercial recycling in U. S., West Germany, Belgium and Italy, while in Japan, interest in the commercial recycling just began to be aroused. Though thermal utilization of plutonium is limited only up to time of FBR introduction, early decision of attitude and policy for its commercial use must be made in Japan, when it is considered that application of plutonium greatly influences nuclear power generation economy. (Japan)

40242 ACCUMULATION OF PLUTONIUM AND ITS RECYCLING. Oi, Hiroshi (Tokyo Electric Power Co. Inc.). Genshiryoku Kogyo; 17: No. 12, 15-18(Dec 1971). (In Japanese).
Plutonium recycling is discussed in view of fuel cycles under pressure of accumulating Pu. The amount of accumulation of Pu is 32 tons in Japan, 166 tons in West Europe, and 268 tons in the U.S.A. by 1985, and will increase much faster afterwards. The merits of Pu recycling are neglect of economic loss in storing Pu for a long period, avoidance of difficulties in storing technology of Pu, and saving in usage of enriched U. It is concluded that Pu recycling is a realistic approach against the accumulation of Pu. Attitudes of the U.S.A. the U.K., Italy, West Germany, and Japan toward the Pu recycling are described. The Pu fuel irradiation program at Mihama is paid much attention. The future scale of the Pu recycling is evaluated. In calculation, it is assumed that all constructed power reactors will be LWRs, and fissile Pu consumption for research use is 1 ton annually. The Pu fuel will occupy more than 10% of the refuel loadings in 1980 and 14.5% in 1985 in Japan. The need for a nation-wide Pu utilization plan is discussed. (Japan)

Safety and Siting

Refer also to abstract 40391.

40243 (ANCR-1053) COMPARISON OF THERMAL-HYDRAULIC RESPONSE OF LOFT AND A LARGE PRESSURIZED WATER REACTOR TO LOCA CONDITIONS. Cederberg, G. K.; Curet, H. D.; Davis, P. R.; Dugone, J.; Jiminez, R. F.; Schmitt, R. C.; Shumway, R. W.; Wadkins, R. P. (Aerojet Nuclear Co., Idaho Falls, Idaho). Apr 1972. Contract AT(10-1)-1375. 60p. Dep. NTIS.
An analytical study was performed to determine how closely the thermal-hydraulic response of the Loss-of-Fluid Test (LOFT) pressurized water reactor [55 MW(t)] with a 5.5-foot-long core compares with that of a large, four-loop, pressurized water reactor [3000 MW(t)] with a 12-foot-long core under loss-of-coolant accident conditions. The analysis employed the thermal-hydraulic computer codes RELAP3 and THETA1-B to determine the hydraulic response of the primary systems during blowdown and the thermal responses of the cores during blowdown. An additional analysis was performed to assess the core thermal response during ECC reflooding. On the basis of the results of the analyses, the conclusion was reached that a 5.5-foot core operating in the LOFT system can produce thermal-hydraulic behavior representative of that calculated to occur in a four-loop large PWR with a 12-foot core during a double-ended inlet pipe break. The inlet pipe break analyzed is generally considered to result in the highest core temperatures for large PWR's. (auth)

40244 (BAW-10031(Rev.1)) REFLOOD: DESCRIPTION OF MODEL FOR MULTINODE CORE REFLOOD ANALYSIS. Revision 1. Bingham, B. E.; Shieh, K. C. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). May 1972. 16p.
The REFLOOD computer program was developed to study the dynamic behavior of reactor core refill transients following a loss-of-coolant accident. A nine-region model was developed to simulate the refill transients. The program calculates flows, inventories, temperatures, and pressures in the primary system during reflooding. The derivation of basic equations, nodal descriptions of the primary system, and the basic assumptions used are presented. (auth)

40245 (BNL-16717(Pt.1)) ROD DROP AND SCRAM IN BOILING WATER REACTORS. Diamond, D. J.; Lellouche, G. S.; Levine, M. M. (Brookhaven National Lab., Upton, N. Y.). Apr 1972. 72p. Dep. NTIS.
One of the design basis accidents in Boiling Water Reactors (BWR) concerns the accidental dropout of a control rod. Under abnormal circumstances, such a rod could be worth several percent in reactivity and initiate a massive power and temperature increase. Some short time after such an accident starts, automatic safety equipment inserts the SCRAM bank and the accident is terminated. Typically, the time scale of interest is only a few (<5) seconds. Some of the methods of calculating the rod drop induced transient behavior of a BWR typified by the Oyster Creek power reactor are studied. (auth)

40246 (CONF-720109-2) THERMAL INTERACTION BETWEEN MOLTEN ALUMINA AND LIQUID SODIUM. Pottinger, R. C.; Rees, N. J. M.; Turner, R. G. (United Kingdom Atomic Energy Authority, Foulness (England)). [1972]. 16p. Dep. NTIS (U. S. Sales Only).
From Meeting on sodium-fuel interaction in fast reactor safety; Grenoble, France (25 Jan 1972).
The initial experiments in a series designed to study the effects of a transient thermal interaction between molten uranium dioxide and liquid sodium in a simple, three-dimensional geometry are described. These experiments are intended to give a better understanding of that part of a maximum credible accident in a fast reactor where the molten core debris and fuel are dispersed into the sodium coolant. They interact thermally to cause a sodium vapor explosion. Because of the precautions required by the UKAEA in handling uranium dioxide powder it was decided to substitute alumina in the first experiments. A pyrotechnic mixture is used both to heat a quantity of alumina and to disperse the heated products and diluent into sodium. No direct method of measuring thermal interaction between molten charge products and sodium is possible, but dynamic measurements of the transient pressures both in the sodium and in the gas space above the sodium are described. (auth)

40247 (HEDL-TME-71-19) RDT STANDARDS SEMINAR, RICHLAND, WASHINGTON, NOVEMBER 17-18, 1970. (Hanford Engineering Development Lab., Richland, Wash.). 1970. Contract AT(45-1)-2170. 65p. Dep. NTIS.
The nuclear codes and standards employed in U. S. power plant development are described and discussed. Standards with applications in Liquid Metal Fast Breeder Reactor programs are emphasized. (H.D.R.)

40248 (IRS-W-2) SAFETY ANALYSIS PLAN. USE OF DIFFERENT SAFETY AND RELIABILITY ANALYSES AT THE RIGHT TIME AND FOR SPECIAL PROBLEMS. Balfanz, H.-P. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). Apr 1972. 41p. (In German). Dep. NTIS (U. S. Sales Only).
A survey of safety and reliability analyses is given. Eight different types of analyses are briefly described and investigated. It is shown what effectiveness and to which time the various analyses can be applied to the different systems; how subsystems can be analyzed, and how the type of analysis depends upon the amount of information available about a specific system. Further it is discussed how completely a system from the general standpoint of safety can be investigated. (23 references) (auth)

40249 (LIB/Trans-418) INVESTIGATION ON THE BLOWDOWN OF A TANK FILLED WITH A SATURATED STEAM-WATER MIXTURE. Sandri, Claudio; Premoli, Angelo (Centro Informazioni Studi Esperienze, Milan (Italy)). Translated by W. Buykx (Australian Atomic Energy Commission), from report CISE-E-819. 15p. Dep. NTIS (U. S. Sales Only).
An analysis and discussion is made of results and limits of some theoretical calculation criteria which require solution of analytical equations with or without small table computers. The work is based on investigations performed with a 3 m^3 tank in support of CIRENE reactor safety problem investigations. Assumptions made regarding tank pressure transient investigation appear satisfactory provided that a suitable choice is made between complete separation and complete mixing of vapor and liquid for the calculation of the steam quality. Horizontal water discharge pressure transients calculated using the homogeneous model for mass flow determination are in reasonable agreement with experimental results as long as the level of the liquid is above the discharge tube. (Australia)

40250 (ORNL-NSIC-99) INDEX TO NUCLEAR SAFETY. A Technical Progress Review by Chronology, Permuted Title, and Author. Vol. 1, No. 1 through Vol. 12, No. 6. Blakely, J. Paul; Klein, Ann (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 128p. Dep. NTIS.

40251 (ORNL-NSIC-102) COMPILATION OF NUCLEAR STANDARDS, 8th EDITION, 1971. PART II. NATIONAL (EXCLUDING U.S.) AND INTERNATIONAL ACTIVITIES. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 140p. Dep. NTIS.

All national and international nuclear standards activities known, except for the U. S. work covered in The Compilation of United States Nuclear Standards, are presented in simple tabular form. The standards activities of all national organizations, technical societies, etc., as well as relevant regulations established by government agencies, are listed in alphabetical order by country or by international organization. It is to be noted that many of the so-called "Standard Activities" listed for the various countries are legal regulations rather than voluntary standards. In some countries there are only the former. Such regulations are included, however, because of their relevance. (18 references) (auth)

40252 INSTRUMENTATION IN THE POWER INDUSTRY. VOLUME 14. INSTRUMENTATION FOR ENVIRONMENT, SAFETY, AND RELIABILITY. Proceedings of the Fourteenth International ISA Power Instrumentation Symposium and the Twenty-Fourth Annual New Jersey—New York ISA Symposium, New York, New York, May 17–19, 1971. Instrum. Power Ind.; 14: 1-101(1971). (CONF-710537).

Included are 14 papers on instrument technology for the electric power industry. A separate abstract was prepared for each of 6 papers concerning nuclear power plant instrumentation. (H.D.R.)

For abstracts of individual papers see: 40253, 40254, 40260, 40261, 40380, and 40381.

40253 MEETING TODAYS NUCLEAR SAFETY REQUIREMENTS. Rhode, G. K. Instrum. Power Ind.; 14: 50-3(1971).

From fourteenth power instrumentation symposium; New York, N. Y. (17 May 1971).

The evolution of U. S. nuclear safety standards originated by the AEC, technical societies, or industry organizations is described. The need for standards in instrumentation and control is stressed. (H.D.R.)

40254 FAULT TREE ANALYSIS FOR REACTOR SYSTEMS. Crosetti, Paul A. (Douglas United Nuclear, Inc., Richland, Wash.). Instrum. Power Ind.; 14: 54-61(1971).

From fourteenth power instrumentation symposium; New York, N. Y. (17 May 1971).

Fault tree analysis with probability evaluation can play a key role in assuring nuclear safety, in improving plant performance and plant life, and in reducing plant operating costs. The technique provides an all inclusive, versatile mathematical tool for analyzing complex systems. Its application can include a complete plant as well as any of the systems and subsystems. Fault tree analysis provides an objective basis for analyzing system design, performing trade-off studies, analyzing common mode failures, demonstrating compliance with AEC requirements, and justifying system changes or additions. The logic of the approach makes it readily understandable and, therefore, it serves as an effective visibility tool for both engineering and management. 8 references. (auth)

40255 NUCLEAR SAFETY. VOLUME 13, NUMBER 4. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. Paul One of Four Technical Progress Reviews Published for the Technical Information Center, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Jul-Aug 1972). 77p. GPO $0.60.

Included are 6 articles on the analysis and control of hazards associated with the use of nuclear energy. A separate abstract was prepared for each article. (H.D.R.)

For abstracts of individual papers see: 38411, 38662, 40204, 40256, 40382, and 40383.

40256 PROGRAM SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Sheldon, Myrtleen (comp.). Nucl. Safety; 13: No. 4, 312-21(Jul-Aug 1972).

40257 TRANSIENT BEHAVIOR OF VIPAC AND PELLET THERMAL REACTOR OXIDE FUELS. Freshley, M. D. (Battelle-Northwest, Richland, Wash.); Harrison, L. J. Nucl. Technol.; 15: No. 4, 177-91(Aug 1972).

The results of comparative transient tests performed in TREAT indicate that the cladding failure threshold energy for non-irradiated vibrationally compacted and pellet-containing oxide fuel capsules is about 270 cal/gm UO_2. Although the cladding failure energy is comparable for the two fuel types, the vipac capsules failed by clad melting due to localized contact with molten UO_2 whereas the pellet-containing capsules failed as a result of the rapid deterioration of the high temperature and molten cladding due to the reaction with steam. When tested at near cladding failure threshold energies, the extent of metal/water reaction is comparable for the two fuel types. (13 references) (auth)

40258 NEW VIBRATIONAL PHENOMENA IN EQUIPMENT AND PLANT. Klapp, Eberhard Ullrich (Technische Univ., Clausthal, Ger.). Chem.-Ing.-Tech.; 44: No. 8, 521-6(Apr 1972). (In German).

More stringent safety requirements for reactor pressure vessels have led to a new insight into the origin of damage to large equipment. In order to recognize, eliminate, or at least limit possible sources of damage, two requirements have to be fulfilled: A more detailed knowledge of the origin of hydroelastic stimulation in order to arrive at quantitative standards of judgement from the hitherto largely phenomenological viewpoint; reliably predicting the response of the stimulated structural units to the external stimulation. Taking the geometry of the annular space as example, as it is used for various heat exchangers and chemical reactor types, mathematical models of varying degrees of depth are discussed and comparisons are made with such experimental results as are available; research objectives are also defined. (11 references) (auth)

40259 CALCULATED RISK IN POWER STATION PLANNING. Stoll, A. (Kraftwerk Union AG, Erlangen, Ger.). Elektrizitaetswirtschaft; 70: No. 18, 537-42(1971). (In German). (CONF-710546-2).

From Annual meeting of VDEW; Mainz, Germany (25 May 1971).

In the construction of nuclear power stations, people use on a large scale system analysis and probability calculus for the risk estimation of safety devices. Putting the present records about the availability into the concept of system analysis, one gets quantitative statements on how the block idea for utilization of decreasing trends in costs is sensible in an economic and operational manner. (INIS)

Steam and Power Conversion System

Refer also to abstracts 38369 and 40388.

Commercial Power Reactors

Physics and Core Engineering

Refer also to abstract 40450.

Control and Instrumentation

40260 DESIGNING AND TESTING FOR RELIABILITY IN REACTOR PRESSURE CONTROL. Nicholson, D. (Canatom Ltd., Montreal). Instrum. Power Ind.; 14: 62-71(1971).

From fourteenth power instrumentation symposium, New York, N. Y. (17 May 1971).

The design and testing of a pressure control system for a boiling light water reactor are described. The reactor steam drum pressure is hydraulically controlled using the turbine governor valves, or during startup or fault conditions, the turbine bypass valves. In order to ensure reliability of operation, the entire system, including the reactor, was simulated on a computer and dynamic performance criteria were established for the control loop. After manufacture the pressure control system was tested in the shop using actual hardware and true lengths of oil piping. Several sets of testing and modifications later, the performance criteria were achieved. The tests were repeated at site during the turbine commissioning phase. After some adjustments, the performance achieved during shop testing was duplicated. Final testing and commissioning of the system at various reactor loads is underway. (auth)

40261 SINUSOIDAL TESTING OF INSTRUMENTATION FOR SEISMIC QUALIFICATION. vonDamm, C. A. (General Electric Co., San Jose, Calif.). Instrum. Power Ind.; 14: 85-7(1971).

From fourteenth power instrumentation symposium; New York, N. Y. (17 May 1971).

A pragmatic approach can effectively be used to satisfy seismic requirements for the testing and designing of electrical hardware for use in nuclear power plant Class I applications. It is possible to conservatively, yet economically, design and test such equipment under worst case conditions without having to meticulously analyze every modal response. (auth)

Containment Systems, Waste Processing, and Radiation Protection

Refer also to abstract 39022.

40262 PROBLEME DES BAUTECHNISCHEN STRAHLENSCHUTZES. IV. Vortraege Gehalten auf einer Sitzung des Fachausschusses Strahlenschutz, Karlsruhe, Germany, 6./7. Oktober 1969. (Problems in Construction of Radiation Protection. IV. Reports Presented at a Meeting on Radiation Protection, Karlsruhe, Germany, October 6–7, 1969). Schultz, H. (ed.). Kernenergie-Studiengesellschaft, No. 18. Munich; Verlag Karl Thiemig KG (1970). 108p. DM 20.00. (CONF-691067).

A collection of six papers on theoretical and applied shielding performance is presented. Handling of effective cross sections for shielding against gamma rays with a POPO P4 and Monte Carlo data library, shielding work in the Ispra Shielding Center, and numerical shielding-transport programs for photons and neutrons are discussed. Fast reactor shielding aspects, and radiation protection for the KWO and Otto Hahn Reactors, respectively, are the subjects of separate papers. (K.S.W.)

Coolant System

40263 SYSTEM OF STEAM COMPENSATION FOR THE VOLUME OF COOLANT OF THE SECOND UNIT AT NOVOVORONEZH NUCLEAR POWER STATION. Mal'tsev, B. K.; Bukrinskii, A. M.; Maksimov, L. P.; Puzyrev, L. N. Therm. Eng. (USSR) (Engl. Transl.); 17: No. 12, 8-12(1970).

Translated from Teploenergetika; 17: No. 12, 11-14(1970).

Systems for volume control in water cooling systems are described and compared. The steam-type pressurizer chosen for Unit 2 of the Novovoronezh Nuclear Power Station is described and its design and performance aspects are discussed. (H.D.R.)

40264 INVESTIGATING THE WATER CONDITIONS IN THE SECOND UNIT AT BELOYARSK NUCLEAR POWER STATION. Gruzdev, N. I.; Shchapov, G. A.; Tipikin, S. A.; Boguslavskii, V. B. (Beloyarsk Nuclear Power Station, USSR). Therm. Eng. (USSR) (Engl. Transl.); 17: No. 12, 22-5(1970).

Translated from Teploenergetika; 17: No. 12, 20-2(1970).

The methods and equipment used to control particulate and chemical impurities in the water coolant of Unit 2 of the Beloyarsk Nuclear Power Station are described. Operating experience with the cooling circuit and feedwater system is discussed. (H.D.R.)

Auxiliary Systems and Engineered Safeguards

40265 (BAW–10043) OVERPRESSURE PROTECTION FOR BABCOCK AND WILCOX PRESSURIZED WATER REACTORS. Carlton, J. D. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). May 1972. 15p.

Information on the degree of overpressure protection in Babcock & Wilcox pressurized water reactor nuclear steam systems is presented. It is demonstrated that the combination of the reactor protection system, the pressurizer safety valves, and the steam system safety valves provides overpressure protection for the most severe transients, which include control rod withdrawal at low power and turbine trip from full power. (auth)

Operation and Economics

40266 (DOCKET-1151–55) ELK RIVER REACTOR. Propose to Load Casks in Air Rather Than Under Water. [Rural Cooperative Power Association, Elk River, Minn.]. 15 Jun 1972. 1p. Dep. NTIS.

40267 (DOCKET-50029–185) YANKEE NUCLEAR POWER STATION. Control Rod Surveillance Program, Increased Drop Time Control Rod No. 19. (Yankee Atomic Electric Co., Westboro, Mass.). 14 Jun 1972. 4p. Dep. NTIS.

40268 (DOCKET-50219–194) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Technical Specifications, Change No. 12. (Directorate of Licensing (AEC), Washington, D. C.). 12 Jun 1972. 4p. Dep. NTIS.

Revised technical specifications are presented for operation with Cycle 2 core. (D.C.C.)

40269 (DOCKET-50237–241) DRESDEN NUCLEAR POWER STATION, UNIT 2. Air Operated Primary Containment Sample Return Isolation Valves Failed to Close During Test. [Commonwealth Edison Co., Chicago, Ill.]. 19 Jun 1972. 2p. Dep. NTIS.

40270 (DOCKET-50244–103) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Overexposure to Radioactive Material of a Plant Workman on May 3, 1972. (Rochester Gas and Electric Corp., N. Y.). 31 May 1972. 2p. Dep. NTIS.

40271 (DOCKET-50245–133) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Action Taken to Correct Items of Noncompliance Brought to Attention Following Inspection on March 13–16, 1972. (Division of Compliance (AEC), Newark, N. J. Region I). 6 Jun 1972. 7p. Dep. NTIS.

Additional information is presented concerning administrative procedures and operation requirements for the control rod worth minimizer program. (D.C.C.)

40272 (DOCKET-50245–134) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence AO-72-15. (Millstone Point Co., Hartford, Conn.). 19 Jun 1972. 3p. Dep. NTIS.

Failure of the outboard isolation condenser supply valve to function is described. (D.C.C.)

40273 (DOCKET-50254–96) QUAD-CITIES STATION, UNIT 1. Northeast Expansion Joint on Condenser Circulating Water System Ruptured. (Commonwealth Edison Co., Cordova, Ill.). 11 Jun 1972. 1p. Dep. NTIS.

40274 (DOCKET-50254–97) QUAD-CITIES STATION, UNIT 1. Steps Taken to Correct Item of Apparent Noncompliance Mentioned in Letter of May 9, 1972. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 12 Jun 1972. 6p. Dep. NTIS.

Information is presented concerning the incorrect procedures used for the temporary deactivation of portions of safety related circuitry. (D.C.C.)

40275 (DOCKET-50254–99) QUAD-CITIES STATION, UNITS 1 AND 2. Variance in Performance of Emergency Power System. (Commonwealth Edison Co., Cordova, Ill.). 23 Jun 1972. 2p. (DOCKET-50265–85). Dep. NTIS.

40276 (DOCKET-50255–88) PALISADES PLANT. Misoperation of Clutch Assembly of Control Rod Drive Mechanism 5. (Consumers Power Co., Jackson, Mich.). 12 Jun 1972. 3p. Dep. NTIS.

40277 (DOCKET-50255–89) PALISADES PLANT. Control Valve No. 1807 Failed to Close Fully. (Consumers Power Co., Jackson, Mich.). 14 Jun 1972. 1p. Dep. NTIS.

40278 (DOCKET-50261–97) H. B. ROBINSON UNIT 2. Containment Spray Pump Found to be Binding. (Carolina Power and Light Co., Hartsville, S. C. (USA)). 7 Jun 1972. 1p. Dep. NTIS.

40279 (DOCKET-50261–98) H. B. ROBINSON UNIT 2. Primary to Secondary Leak in "A" Steam Generator. (Carolina Power and Light Co., Raleigh, N. C.). 9 Jun 1972. 1p. Dep. NTIS.

40280 (DOCKET-50261–99) H. B. ROBINSON UNIT 2. Binding of "A" Containment Spray Pump. (Carolina Power and Light Co., Raleigh, N. C.). 16 Jun 1972. 1p. Dep. NTIS.

40281 (DOCKET-50263–124) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. 1AR Transformer Cable Fault. (Northern States Power Co., Minneapolis, Minn.). 9 May 1972. 1p. Dep. NTIS.

40282 (DOCKET-50263–128) MONTICELLO NUCLEAR GENERATING PLANT. Head Spray Isolation Valve Failing to Close. (Northern States Power Co., Minneapolis, Minn.). 13 Jun 1972. 1p. Dep. NTIS.

40283 (DOCKET-50265–82) QUAD-CITIES STATION, UNIT 2. Torus Suction Header Discovered to be Damaged and Displaced from Normal Position on May 29, 1972. (Commonwealth Edison Co., Cordova, Ill.). 30 May 1972. 1p. Dep. NTIS.

40284 (DOCKET-50265–83) QUAD-CITIES STATION, UNIT 2. Failure of Four Hanger Bolts for the Torus Suction Header. (Commonwealth Edison Co., Cordova, Ill.). 7 Jun 1972. 8p. Dep. NTIS.

40285 (DOCKET-50265–84) QUAD-CITIES STATION, UNIT 2. Bolts in Four Hangers for the Torus Suction Header Pipe Failed. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 2 Jun 1972. 2p. Dep. NTIS.

40286 (DOCKET-50266–68) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Inoperable Diesel Fast Start Backup Relays. (Wisconsin Electric Power Co., Milwaukee). 17 Jun 1972. 2p. (DOCKET-50301–59). Dep. NTIS.

40287 (DOCKET-50266–69) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Failure of Circuit Breaker Overcurrent Trip Delay Device. (Wisconsin Electric Power Co., Milwaukee). 17 Jun 1972. 3p. (DOCKET-50301–60). Dep. NTIS.

40288 (DOCKET-50271-82) VERMONT YANKEE NUCLEAR POWER STATION. Operation Report 72-3. (Vermont Yankee Nuclear Power Corp., Rutland). 8 Jun 1972. 25p. Dep. NTIS.

40289 (DOCKET-50293-75) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-72-1. (Boston Edison Co., Mass.). 12 Jun 1972. 5p. Dep. NTIS.

An incorrect setpoint for the relief valve of the standby liquid control system is discussed. Corrective actions are described. (D.C.C.)

40290 (HEDL-TME-72-31) ALPS, A LINEAR PROGRAMMING SYSTEM FOR FORECASTING OPTIMUM POWER GROWTH PATTERNS. Hardie, R. W.; Black, W. E.; Little, W. W. (Hanford Engineering Development Lab., Richland, Wash.). Apr 1972. Contract AT(45-1)-2170. 110p. Dep. NTIS.

The linear programming system, ALPS, which predicts the optimum growth pattern in a mix of fossil and nuclear power plants is presented. Plants are selected to minimize the total discounted costs while satisfying constraints on energy demand, fuel availability, introduction dates, and construction rates. The ALPS model consists of the MAJOR matrix generator code, any generalized LP code, and the SCRIBE report writer code. ALPS is similar to the POWERCO, PACTOLUS, DAEDALUS, CLOTHO, LP (BONNER-MOORE), and MERCURY code series, used in previous AEC LMFBR Cost/Benefit Studies, but was designed to be machine independent and more compact. 11 references. (auth)

40291 (INR-1375) STATUS AND PERSPECTIVES OF NUCLEAR POWER IN THE WORLD AT THE END OF THE YEAR 1970. Hibner, Waclaw (Institute of Nuclear Research, Warsaw (Poland)). 1972. 55p. (In Polish). Dep. NTIS (U. S. Sales Only).

The existing nuclear power stations and those under construction at the end of 1970 are presented. The plans for development of nuclear power in the world are discussed. Also the types of the installed reactors and their average capacities are given. (71 references) (auth)

40292 (TID-26045) GARIGLIANO NUCLEAR POWER STATION. Operation Report for the 4th Quarter of 1971. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 31 Dec 1971. 23p. Dep. NTIS.

40293 (ZJE-108) ANALYSIS OF UNNOMINAL STEADY STATES OF A-1 NUCLEAR POWER STATION. Bis, J.; Kotyza, V.; Leitner, Z.; Toufar, P. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 21p. Dep. NTIS (U. S. Sales Only).

Calculation methods are explained and brief descriptions of the mathematical model and analysis of the basic results are given. The study is a part of the MARCOS program (Model Analysis of the Reactor Cooling Systems) which is the basis of the nuclear station start-up project. (auth)

40294 OPERATIONS SUMMARY OF THE GERMAN NUCLEAR POWER PLANTS DURING 1971. Atomwirt., Atomtech.; 17: No. 6, 325-30(Jun 1972). (In German).

During 1971, the major part of nuclear energy amounting to 6373 GWh was produced by prototype and demonstration power plants. Of the large scale commercial power plants, only that at Wuergassen became operational with 370 MW(e). Since several fires occurred during the year, fire monitoring and fire protection were increased and should be enhanced in the design of future plants. The problem of radioactive contamination of components and hazards to repair crews should be decreased by better designs and arrangements. Improved decontamination procedures should be developed for tubings, pumps, and other components. During 1971, the average operational time of all power plants in West Germany was 79.6%. Data were compiled for the following plants: Gundremmingen, Obrigheim, Lingen, Karlsruhe, Kahl, Juelich, and Wuergassen. (H.B.G.)

40295 NUCLEAR ENERGY: PROSPECTS FOR THE FUTURE. Amyot, Laurent. Ingenieur (Montreal); 58: No. 276, 4-15(Mar 1972). (In French).

The potential role of nuclear power in filling world energy needs is surveyed, with particular attention to the situation in the U. S. and Canada. Figures are given for installed electrical power and nuclear reactors ordered in the U. S., and several predictions of installed nuclear power to 1980 are compared. The energy situation in various areas of Canada is considered. Reactors built and under construction are summarized, with figures for predicted nuclear power for Ontario to the year 2000. Tables give figures for installed power sources in Quebec and potentially exploitable hydroelectric power. Types of reactors favored by various countries are described and related to the factors which led to their selection. Environmental effects, including the effects and hazards of radiation and the problem of thermal pollution, are discussed. (Canada)

Safety and Siting

Refer also to abstract 39023.

40296 (AECL-4156) SOME ASPECTS OF THE RELEASES OF RADIOACTIVITY AND HEAT TO THE ENVIRONMENT FROM NUCLEAR REACTORS IN CANADA. Barry, P. J. (ed.) (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1972. 85p. Dep. NTIS (U. S. Sales Only). AECL $2.00.

Recent interest in the quality of the environment has led to an increasing demand for information on the amounts and consequences of releases of radioactive substances and heat to the environment from nuclear reactors. Eight papers on this subject are presented. Five of these were published independently, and abstracts have appeared for four (20: 45942; 24: 50925; 25: 54016; 25: 55194); the fifth is a book review of a conference proceedings, "Engineering Aspects of Thermal Pollution." Two of the papers are transcripts of conference papers for which abstracts of the published version have appeared (24: 50925; 25: 54016). Summaries of the releases of radioactivity to the atmosphere and water from three Canadian reactors (Douglas Point, NPD, and Gentilly) are given in the remaining paper. The radioactive products generated in these reactors and the mechanisms by which they are released are discussed. (Canada)

40297 (BAW-10031(Suppl.1)) REFLOOD: DESCRIPTION OF MODEL FOR MULTINODE CORE REFLOOD ANALYSIS. Parks, C. E.; Shieh, K. C. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Apr 1972. 29p.

The REFLOOD computer program was developed to study the dynamic behavior of reactor core refill transients following a loss-of-coolant accident. REFLOOD-2, a modified version of the REFLOOD code used to analyze refill transients for B & W plants without internal vent valves, is described. The program calculates flows, inventories, temperatures, and pressures in the reactor coolant system during reflooding. The derivation of basic equations, nodal descriptions of the reactor coolant system, and the basic assumptions used are included. (auth)

40298 (BAW-10045) MULTINODE ANALYSIS OF B and W's 205-FUEL-ASSEMBLY NUCLEAR PLANTS DURING LOSS-OF-COOLANT ACCIDENT. Parks, C. E.; Schermer, W. J.; Shieh, K. C.; Dunn, B. M. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). May 1972. 107p.

Multinode analyses were conducted to evaluate several loss-of-coolant accidents for nuclear plants with 205 fuel assemblies. The multinode blowdown code, CRAFT, the reflooding code, REFLOOD, and the cladding heatup code, THETA 1-B, were used to perform these analyses at a core power of 3760 MW(t). Curves showing the parameters of interest are presented. Results of the analyses indicate that the emergency core cooling system will terminate the cladding temperature transient and limit the course of the LOCA in accordance with the AEC Interim Acceptance Criteria. (7 references) (auth)

40299 (COO-3062-3) DESIGN AND SITING CRITERIA FOR ONCE-THROUGH COOLING SYSTEMS BASED ON A FIRST-ORDER THERMAL PLUME MODEL. Technical Report No. 75. Pritchard, D. W.; Carter, H. H. (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Apr 1972. Contract AT(30-1)-3109. 54p. Dep. NTIS.

The processes which control the distribution of excess temperature in the heated plume resulting from the discharge of a heated effluent into a natural waterbody are discussed, and the relative importance of each process for various plant design and environmental conditions is assessed. The distributions of excess temperature and the time-temperature history of exposure of organisms entrained into the thermal plume resulting from the discharge of condenser cooling water from a 1000 MW(e) nuclear power plant are given for several alternate sets of design criteria for the discharge structure. It is shown that, in order to minimize adverse effects on natural water bodies used to supply condenser cooling water flow for once-through cooling systems, the power plant should be located on a waterway having large dilution capacity, and the discharge structure should be designed to promote rapid dilution of the heated effluent by the cooler receiving waters. Intake structures should be designed to provide for low intake velocities, and to provide an effective means of diverting fish and other aquatic organisms away from the intake. Time of travel of the condenser cooling water flow from the condensers to the point of discharge should be kept small, in order to minimize the time of exposure of entrained organisms to the maximum temperature rise. 16 references. (auth)

40300 (DOCKET-50003–114) INDIAN POINT STATION, UNIT 1. Petition for Full-Term Operating License DPR-5, Amendment 3 With Technical Specifications. (Consolidated Edison Co. of New York, Inc., New York). 28 Apr 1972. 245p. Dep. NTIS.

Requested additional information is presented concerning design parameters and operating aspects of the reactor. Technical specifications are included. (D.C.C.)

40301 (DOCKET-50003–115) INDIAN POINT STATION, UNIT 1. General Design Criteria Review for Full-Term Operating License DPR-5. (Consolidated Edison Co. of New York, Inc., New York). 9 Jun 1972. 5p. Dep. NTIS.

Requested additional information is presented concerning the inspection and testing requirements for the containment air cleanup system. (D.C.C.)

40302 (DOCKET-50010–109) DRESDEN NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Proposed Revision. (Commonwealth Edison Co., Chicago, Ill.). 15 Jun 1972. 168p. Dep. NTIS.

40303 (DOCKET-50010–110) DRESDEN NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Change No. 17. (Directorate of Licensing (AEC), Washington, D. C.). 6 Jun 1972. 12p. Dep. NTIS.

Revised technical specifications are presented concerning the installation of an emergency core cooling system. (D.C.C.)

40304 (DOCKET-50010–111) DRESDEN NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Change No. 21. Directorate of Licensing (AEC), Washington, D. C.). 13 Jun 1972. 27p. Dep. NTIS.

Revised technical specifications are presented concerning gaseous radioactive discharge limits, personnel, and operating procedures. (D.C.C.)

40305 (DOCKET-50155–114) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Proposed Change No. 31. (Consumers Power Co., Jackson, Mich.). 16 Jun 1972. 46p. Dep. NTIS.

Revised technical specifications are presented concerning the use of PuO_2-UO_2 fuel rods designated Reload G. (D.C.C.)

40306 (DOCKET-50171–104) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Technical Specifications, Change 15. (Division of Reactor Licensing (AEC), Washington, D. C.). 10 Apr 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the use of a plutonium fuel test element, FTE-13, in Core 2. (D.C.C.)

40307 (DOCKET-50213–142) HADDAM NECK PLANT, UNIT 1. Results of Detailed Nuclear and Thermal Hydraulic Analysis Performed for Cycle 4. (Connecticut Yankee Atomic Power Co., Hartford). 6 Jun 1972. 7p. Dep. NTIS.

40308 (DOCKET-50220–97) NINE MILE POINT NUCLEAR STATION, UNIT 1. Steps Taken to Preclude Control Rod Drop Accident. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 16 Jun 1972. 4p. Dep. NTIS.

40309 (DOCKET-50244–102) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Additional Information Concerning Revision of 1520 MWt Technical Specifications, Change No. 1. (Rochester Gas and Electric Corp., N. Y.). 12 Jun 1972. 2p. Dep. NTIS.

Additional information is presented concerning the revised Cycle 2 core loading pattern and control rod insertion limits. (D.C.C.)

40310 (DOCKET-50247–74) INDIAN POINT NUCLEAR GENERATING UNIT 2. Report, WNET–102, Part 2: Technical Report on Steam Generator Tubesheet Cladding. (Westinghouse Electric Corp., Tampa, Fla.). 12 May 1972. 64p. Dep. NTIS.

40311 (DOCKET-50250–83) TURKEY POINT PLANT, UNITS 3 AND 4. Proposed Technical Specifications for Cooling System. (Florida Power and Light Co.). 14 Jun 1972. 29p. (DOCKET-50251–69). Dep. NTIS.

Technical specifications are presented concerning the operating limits for the secondary cooling system. (D.C.C.)

40312 (DOCKET-50254–94) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Change 2. (Directorate of Licensing (AEC), Washington, D. C.). 22 May 1972. 11p. (DOCKET-50265–80). Dep. NTIS.

Revised technical specifications are presented concerning the use by personnel of respiratory protective equipment. (D.C.C.)

40313 (DOCKET-50254–95) QUAD-CITIES STATION, UNITS 1 AND 2. Draft Detailed Statement on Environmental Considerations Related to the Proposed Issuance of an Operating License, Addendum I. (Directorate of Licensing (AEC), Washington, D. C.). 7 Jun 1972. 25p. (DOCKET-50265–81). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Environmental considerations for a two unit spray canal for the condenser water cooling system are discussed. (D.C.C.)

40314 (DOCKET-50255–90) PALISADES PLANT. Inspection Made to Confirm Source of Shoulder Bolt. (Consumers Power Co., Jackson, Mich.). 15 Jun 1972. 2p. Dep. NTIS.

Confirmation of the source of a shoulder bolt in the plenum of the No. 2 steam generator is presented. The bolt is one of the upper guide structure ring shim bolts. (D.C.C.)

40315 (DOCKET-50255–91) PALISADES PLANT. SIRW Tank Rupture Accident Analysis. (Consumers Power Co., Jackson, Mich.). 22 Jun 1972. 3p. Dep. NTIS.

40316 (DOCKET-50259–52) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Radiological Emergency Plan, Revision June 1, 1972. (Tennessee Valley Authority, Chattanooga). 9 Jun 1972. 40p. (DOCKET-50260–49; DOCKET-50296–46). Dep. NTIS.

40317 (DOCKET-50259–53) BROWNS FERRY NUCLEAR POWER STATION, UNIT 1. Steps Taken to Correct Items of Apparent Noncompliance Listed in Letter Dated May 4, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 15 Jun 1972. 12p. Dep. NTIS.

Information is presented concerning the preoperational test program and quality assurance requirements for instrumentation electrical cable installation. (D.C.C.)

40318 (DOCKET-50263–126) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Summary of Monticello Biological Shield Wall Strength. (Northern States Power Co., Minneapolis, Minn.). 8 Jun 1972. 5p. Dep. NTIS.

40319 (DOCKET-50263–127) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Steps Taken to Correct Item of Apparent Noncompliance Mentioned in Letter of May 9, 1972. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 6 Jun 1972. 6p. Dep. NTIS.

Information is presented concerning the relocation of the trip test potentiometers for the main steam line radiation monitor. (D.C.C.)

40320 (DOCKET-50263–129) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Application for Conversion of DPR-22 to Full Term. (Northern States Power Co., Minneapolis, Minn.). 15 Jun 1972. 167p. Dep. NTIS.

40321 (DOCKET-50267–45) FORT ST. VRAIN NUCLEAR GENERATING STATION. Steps Taken to Correct Items of Apparent Noncompliance Listed in Letter of May 11, 1972. (Directorate of Regulatory Operations (AEC), Denver, Colo. Region IV). 15 Jun 1972. 14p. Dep. NTIS.

Additional information is presented concerning the preoperational test program and quality assurance program. (D.C.C.)

40322 (DOCKET-50271–81) VERMONT YANKEE NUCLEAR POWER STATION. Addition of Charcoal Filters and Modification of Relief Valve Discharge Piping. (Vermont Yankee Nuclear Power Corp., Rutland). 5 Jun 1972. 4p. Dep. NTIS.

40323 (DOCKET-50271–83) VERMONT YANKEE NUCLEAR POWER STATION. Attachment A, Vermont Yankee Advanced Offgas Modification System. (Vermont Yankee Nuclear Power Corp., Rutland). 16 Jun 1972. 79p. Dep. NTIS.

40324 (DOCKET-50277–39) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. License Application, Amendment 17. (Philadelphia Electric Co., Pa.). 13 Jun 1972. 121p. (DOCKET-50278–45). Dep. NTIS.

Financial data on the owners of Peach Bottom Power Reactor Units 2 and 3 are presented. The 1971 Annual Reports for the Philadelphia Electric Company, the Public Service Electric and Gas Company, the Delmarva Power and Light Company, and the Atlantic City Electric Company are included. (D.C.C.)

40325 (DOCKET-50277–46) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Evaluation of the Blowdown Forces From Discharge Lines into the Torus. (Philadelphia Electric Co., Pa.). 12 Jun 1972. 5p. (DOCKET-50278–46). Dep. NTIS.

40326 (DOCKET-50277-47) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment No. 18. (Philadelphia Electric Co., Pa.). 15 Jun 1972. 42p. (DOCKET-50278-47). Dep. NTIS.

Revised design parameters of the Peach Bottom Power Reactor Units 2 and 3 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

40327 (DOCKET-50282-55) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Environmental Report, Supplement 1. (Northern States Power Co., Minneapolis, Minn.). 7 Jun 1972. 64p. (DOCKET-50306-53). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Information concerning site biota is included. (D.C.C.)

40328 (DOCKET-50282-56) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 18. (Northern States Power Co., Minneapolis, Minn.). 9 Jun 1972. 267p. (DOCKET-50306-54). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. Coolant loss accident conditions are analyzed. Evaluation of the containment system is presented. (D.C.C.)

40329 (DOCKET-50293-73) PILGRIM NUCLEAR POWER STATION. Facility Operating License DPR-35, Including Technical Specifications and Bases. (Directorate of Licensing (AEC), Washington, D. C.). 8 Jun 1972. 245p. Dep. NTIS.

40330 (DOCKET-50293-74) PILGRIM NUCLEAR POWER STATION. Safety Evaluation, Supplement 1. (Directorate of Licensing (AEC), Washington, D. C.). 13 Jun 1972. 33p. Dep. NTIS.

Technical evaluation is presented for the augmented radioactive waste disposal systems and radioactivity release limits. (D.C.C.)

40331 (DOCKET-50295-52) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Measures to be Taken to Assure Wall Thickness of Class I Cast Valves. (Directorate of Regulatory Operations (AEC), Glen Ellyn, Ill. Region III). 13 Jun 1972. 2p. (DOCKET-50304-52). Dep. NTIS.

40332 (DOCKET-50295-53) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Field Sampling Program, Part C: Fish Study, March 1970 to October 1970. (Commonwealth Edison Co., Chicago, Ill.). 13 Jun 1972. 19p. (DOCKET-50304-53). Dep. NTIS.

40333 (DOCKET-50302-49) CRYSTAL RIVER NUCLEAR PLANT, UNIT 3. Final Safety Analysis Report, Amendment 21. (Florida Power Corp., St. Petersburg). 15 May 1972. 113p. Dep. NTIS.

Revised design parameters of the Crystal River Power Reactor Unit 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

40334 (DOCKET-50305-42) KEWAUNEE NUCLEAR POWER PLANT. Control of Acidity of the Containment Spray Solution. (Wisconsin Public Service Corp., Green Bay). 15 Jun 1972. 1p. Dep. NTIS.

40335 (DOCKET-50309-60) MAINE YANKEE ATOMIC POWER STATION. Proposed Power Escalation Test Program. (Maine Yankee Atomic Power Co., Westboro, Mass.). 8 Jun 1972. 13p. Dep. NTIS.

40336 (DOCKET-50312-39) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment 11. (Sacramento Municipal Utility District, Calif.). 5 Jun 1972. 118p. Dep. NTIS.

Revised and additional data on the quality assurance program are presented. Meteorological data for the reactor site are included. (D.C.C.)

40337 (DOCKET-50312-40) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Steps Taken to Correct Items Listed in Letter of May 4, 1972. (Directorate of Regulatory Operations (AEC), Berkeley, Calif. (USA). Region V). 7 Jun 1972. 3p. Dep. NTIS.

Additional information is presented concerning the identification and storage of specific pipe flanges, and radiographic examination of containment lines welds. (D.C.C.)

40338 (DOCKET-50321-43) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Summary of Reactor Pressure Vessel Repairs. (Georgia Power Co., Atlanta). 13 Jun 1972. 79p. Dep. NTIS.

40339 (DOCKET-50321-44) EDWIN I. HATCH NUCLEAR PLANT, UNITS 1 AND 2. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Jun 1972. 128p. (DOCKET-50366-28). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Ecological, geological, and hydrological data for the reactor site are included. Cost-benefit analysis for reactor operation is presented. (D.C.C.)

40340 (DOCKET-50321-45) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Steps Taken to Correct Item of Apparent Noncompliance Mentioned in Letter of April 20, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 16 Jun 1972. 5p. Dep. NTIS.

Requested additional information is presented concerning adequate wall thickness for the main steam isolation valves. (D.C.C.)

40341 (DOCKET-50322-27) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Environmental Report, Construction Permit Stage, Errata. (Long Island Lighting Co., Hicksville, N. Y.). 19 May 1972. 10p. Dep. NTIS.

Corrected information is presented concerning cooling tower costs, circulating water discharge system, site topography, and reactor off gas system. (D.C.C.)

40342 (DOCKET-50331-47) DUANE ARNOLD ENERGY CENTER. Control of Combustible Gas Concentrations in Containment Following a Loss-of-Coolant Accident. (Iowa Electric Light and Power Co., Cedar Rapids). 1 Jun 1972. 2p. Dep. NTIS.

40343 (DOCKET-50333-47) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Environmental Report, Supplement 2, Benefit/Cost Analysis. (Power Authority of the State of New York). May 1972. 31p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for reactor operation is included. (D.C.C.)

40344 (DOCKET-50338-45) NORTH ANNA POWER STATION, UNITS 1 AND 2. Request Expeditious Preparation of Draft and Final Detailed Statements. (Virginia Electric and Power Co., Richmond). 6 Jun 1972. 2p. (DOCKET-50339-42). Dep. NTIS.

Request for continued construction of power transmission lines during NEPA review period is presented. (D.C.C.)

40345 (DOCKET-50338-46) NORTH ANNA POWER STATION, UNITS 1, 2, 3, AND 4. Environmental Report, Revision 1. (Virginia Electric and Power Co., Richmond). 15 Jun 1972. 121p. (DOCKET-50339-43; DOCKET-50404-16; DOCKET-50405-16). Dep. NTIS.

Additional information is presented concerning chemical and thermal discharges from the reactors. Environmental aspects of transmission lines are described. Financial aspects of operation are analyzed. Hydrological data for the reactor site are included. (D.C.C.)

40346 (DOCKET-50346-26) DAVIS-BESSE NUCLEAR POWER STATION. Concrete Investigation. (Division of Compliance (AEC), Glen Ellyn, Ill. Region III). 13 Mar 1972. 20p. Dep. NTIS.

40347 (DOCKET-50348-41) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Supplement to Environmental Report, Amendment 3. (Alabama Power Co., Birmingham). 6 Jun 1972. 16p. (DOCKET-50364-35). Dep. NTIS.

Additional information is presented on site biota. (D.C.C.)

40348 (DOCKET-50354-23) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Safety Evaluation, Errata and Additional Information. (Directorate of Licensing (AEC), Washington, D. C.). 13 Jun 1972. 5p. (DOCKET-50355-23). Dep. NTIS.

Safety analysis for a control rod drop accident is presented. (D.C.C.)

40349 (DOCKET-50363-27) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Statement of Reasons Why Exemption Should be Granted to Allow Certain Site Preparation Activities. (Jersey Central Power and Light Co., Morristown, N. J.). 9 Jun 1972. 41p. Dep. NTIS.

40350 (DOCKET-50369-25) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Revision No. 3. (Duke

Power Co., Charlotte, N. C.). 20 Jun 1972. 47p. (DOCKET-50370–25). Dep. NTIS.

Additional information is presented concerning biota for the site, hydrology, and construction effects. Design parameters for the main turbine surface condenser equipment are included. (D.C.C.)

40351 (DOCKET-50373–21) LA SALLE COUNTY STATION, UNITS 1 AND 2. Environmental Report, Supplement 2. (Commonwealth Edison Co., Chicago, Ill.). 14 Feb 1972. 190p. (DOCKET-50374–21). Dep. NTIS.

Information concerning thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for reactor operations is presented. (D.C.C.)

40352 (DOCKET-50373–22) LA SALLE COUNTY STATION, UNITS 1 AND 2. Environmental Report, Supplement 6. (Commonwealth Edison Co., Chicago, Ill.). 12 Jun 1972. 223p. (DOCKET-50374–22). Dep. NTIS.

Ecological, geological, hydrological, and seismological data on the reactor site are presented. Requested additional information concerning thermal discharges from the reactors is included. (D.C.C.)

40353 (DOCKET-50382–23) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment No. 15. (Louisiana Power and Light Co., New Orleans). 19 Jun 1972. 267p. Dep. NTIS.

Revised design parameters of the Waterford Power Reactor Unit 3 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

40354 (DOCKET-50382–24) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 16. (Louisiana Power and Light Co., New Orleans). 30 Jun 1972. 28p. Dep. NTIS.

Revised information is presented concerning process instrumentation. Requested additional data are included concerning the reactor site and radioactive effluents. (D.C.C.)

40355 (DOCKET-50387–18) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Safety Evaluation. (Directorate of Licensing (AEC), Washington, D. C.). 21 Jun 1972. 133p. (DOCKET-50388–18). Dep. NTIS.

40356 (DOCKET-50390–16) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 10. (Tennessee Valley Authority, Chattanooga). 22 Jun 1972. 78p. (DOCKET-50391–16). Dep. NTIS.

Revised design parameters of the Watts Bar Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

40357 (DOCKET-50395–20) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Environmental Report, Supplement No. 3. (South Carolina Electric and Gas Co., Columbia). 19 Jun 1972. 6p. Dep. NTIS.

Additional information is presented concerning the population distribution around the reactor site. (D.C.C.)

40358 (DOCKET-50400–18) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 9. (Carolina Power and Light Co., Raleigh, N. C.). 30 Jun 1972. 422p. (DOCKET-50401–18; DOCKET-50402–18; DOCKET-50403–18). Dep. NTIS.

Revised design parameters of the Shearon Harris Power Reactor Units 1, 2, 3, and 4 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing (D.C.C.)

40359 (DOCKET-50409–2) LA CROSSE BOILING WATER REACTOR. Technical Evaluation of Adequacy of Emergency Core Cooling System. (Dairyland Power Cooperative, La Crosse, Wis.). 5 Jun 1972. 151p. Dep. NTIS.

40360 (DOCKET-50410–1) NINE MILE POINT NUCLEAR STATION, UNIT 2. Application for Licenses. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 15 Jun 1972. 44p. Dep. NTIS.

Application for construction permit and operation license is presented. Financial data on the owners of the reactor are also presented. The 1971 Annual Report of the Niagara Mohawk Power Corporation is included. (D.C.C.)

40361 (DOCKET-50410–2) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Volume 1. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Jun 1972. 375p. Dep. NTIS.

Information is presented for the Nine Mile Point Power Reactor Unit 2 under the heading of reactor site. (D.C.C.)

40362 (DOCKET-50410–3) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Volume 2. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Jun 1972. 495p. Dep. NTIS.

Information is presented for the Nine Mile Point Power Reactor Unit 2 under the following broad topics: reactor; cooling system; and containment. (D.C.C.)

40363 (DOCKET-50410–4) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Volume 3. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Jun 1972. 553p. Dep. NTIS.

Information is presented for the Nine Mile Point Power Reactor Unit 2 under the following main headings: emergency core cooling system; and control and instrumentation. (D.C.C.)

40364 (DOCKET-50410–5) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Volume 4. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Jun 1972. 615p. Dep. NTIS.

Information on Nine Mile Point Power Reactor Unit 2 is presented under the following broad topics: electrical systems; radioactive waste systems; auxiliary systems; steam and power conversion system; structures and shielding; and conduct of operations. (D.C.C.)

40365 (DOCKET-50410–6) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Volume 5. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Jun 1972. 675p. Dep. NTIS.

Information on Nine Mile Point Power Reactor Unit 2 is presented under the following topics: safety analysis; technical specifications; component design limits; and quality assurance program. (D.C.C.)

40366 (DOCKET-50410–7) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Volume 6. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Jun 1972. 761p. Dep. NTIS.

Information on Nine Mile Point Power Reactor Unit 2 is presented under the following topics: operations aspects; gaseous stack effluent releases; and site geology, hydrology, and seismology. (D.C.C.)

40367 (DOCKET-50410–8) NINE MILE POINT NUCLEAR STATION, UNIT 2. Environmental Report, Construction Permit Stage. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Jun 1972. 407p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Ecological, geological, hydrological, and meteorological data for the reactor site are presented. Cost-benefit analysis for reactor operation is included. (D.C.C.)

40368 (DOCKET-RESARA–6) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 1. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 209p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented under the broad topics of general description of the power plant, and design requirements for structures and components. (D.C.C.)

40369 (DOCKET-RESARA–7) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 2. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 287p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented under the topic of reactor design parameters. (D.C.C.)

40370 (DOCKET-RESARA–8) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 3. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 346p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented under the broad topics of cooling system and engineered safeguards. (D.C.C.)

40371 (DOCKET-RESARA–9) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 4. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 283p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented under the main heading of instrumentation and controls. (D.C.C.)

40372 (DOCKET-RESARA-10) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 5. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 273p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented under the broad topics of auxiliary systems and radioactive waste management. (D.C.C.)

40373 (DOCKET-RESARA-11) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 6. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 262p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented under the broad topics of initial tests and operations and accident analysis. (D.C.C.)

40374 (DOCKET-RESARA-12) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 7. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 313p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented under the broad topic of accident analysis. (D.C.C.)

40375 (DOCKET-RESARA-13) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Volume 8. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. 273p. Dep. NTIS.

Information required for the licensing of pressurized-water power reactors is presented on the topics of technical specifications and quality assurance program. (D.C.C.)

40376 (FIND-50259(5-72)) FIND: BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Revision 1. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 15 May 1972. 47p. (FIND-50260(5-72); FIND-50296(5-72)). Dep. NTIS.

The Browns Ferry Nuclear Power Station project items microfiched and announced in NSA are listed. All DOCKET items issued up to May 15, 1972, are included. (H.D.R.)

40377 (IRS-W-3) FORMAL QUESTIONS OF THE LEGAL STRUCTURE OF LICENSING PROCEDURES WITH THE TECHNIQUE OF NETWORK PLANNING. Drittler, K. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). Apr 1972. 27p. (In German). Dep. NTIS (U. S. Sales Only).

Various alternatives of the technique of network planning, concerning the licensing of nuclear facilities, are compared as to their advantages and disadvantages. The application of the common technique of network planning is demonstrated in an example involving the approval of the primary portion of facility construction. If the common technique of network planning is used, a large amount of effort must be expended in order to obtain a clear perspective of the legal structure of licensing procedures. However, by extending the method of common technique, a clear perspective of the legal procedures is obtained along with a considerable reduction of the amount of effort that usually must be expended. (auth)

40378 (NP-19298) SEICHES IN JERVIS BAY, N.S.W.; THEORY VERSUS EXPERIMENT. Bulletin No. 27. Clarke, D. J. (Wollongong Univ. Coll. (Australia)). Nov 1971. 14p. Dep. NTIS (U. S. Sales Only).

Jervis Bay has become the subject of environmental studies because inter alia a proposed nuclear power reactor sited south of Bowen Island is to be cooled by bay water. Six longitudinal free oscillations of periods 33.6, 20.0, 14.2, 10.8, 8.7, and 7.2 min were determined for a one dimensional flow model with approximate solution to the boundary value problem based on the Galerkin method. Since seiches in the bay are of the order of 35 min or less, tidal flow was neglected. Measured power spectral values for the bay on 15 May 1968 had reasonably matched values of 33.75, 20.0, 13.8, 10.1, 8.3 and 6.6, as well as values of 24.0, 17.4, 11.7, 9.0 and 7.3. These non-matched values are attributed to oscillations through the bay entrance. (Australia)

40379 (ORNL-NSIC-97) INDEXED BIBLIOGRAPHY OF THERMAL EFFECTS LITERATURE-2. Morgan, J. G.; Coutant, C. C. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 278p. Dep. NTIS.

The second volume in the series of indexed bibliographies of thermal effects literature published by the Nuclear Safety Information Center is presented. It contains new material that has appeared in the literature during 1970 and 1971. The sources for this bibliography include technical journals, government sponsored reports, technical reports from universities, and conferences dealing with thermal discharges. (auth)

40380 USE OF FIELD INSTRUMENTS IN THE OPERATION OF ENVIRONMENTAL SURVEYS AROUND NUCLEAR POWER PLANTS. Plato, Phillip A.; Gelskey, Dale E. (Univ. of Michigan, Ann Arbor). Instrum. Power Ind.; 14: 1-5(1971).

From fourteenth power instrumentation symposium; New York, N. Y. (17 May 1971).

A device was built which permits the quantitative identification of radionuclides present in undisturbed sediments of lakes and streams. The device was used on sediments around several nuclear power plants. Field measurements also were made on the soil of a dairy farm near a nuclear power plant. The device permits environmental measurements to be made over larger areas and with better sensitivity than is possible using conventional sampling methods. (auth)

40381 NUCLEAR GENERATING STATION RELIABILITY PERSPECTIVES. Bassett, Thomas G. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Instrum. Power Ind.; 14: 88-91(1971).

From fourteenth power instrumentation symposium; New York, N. Y. (17 May 1971).

On occasion, designers worry that reactor operating forces fail to understand the reasons for system complexity, or for certain reliability testing or surveillance requirements of the systems. Conversely, the operating forces sometimes worry that the same system complexity and the testing requirements are incompatible with their strivings to achieve reliability through smooth, effortless and uninterrupted operation. As a mechanism to compare these perspectives, several of the "1967 Atomic Energy Commission General Design Criteria" bearing on reliability with the objective of describing effects and considerations involved in complying with the criteria are discussed. (auth)

40382 SAFETY-RELATED OCCURRENCES REPORTED IN FEBRUARY-MARCH 1972. Castro, William R. (comp.). Nucl. Safety; 13: No. 4, 301-3(Jul-Aug 1972).

40383 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. Paul (comp.). Nucl. Safety; 13: No. 4, 326-45 (Jul-Aug 1972).

Propulsion and Auxiliary Power Reactors

Refer also to abstract 38820.

40384 (ORNL-TM-3647) INSPECTION OF EUROPIUM-BEARING CONTROL ROD ABSORBER OM-2 FROM CORE II AND CORE III OF THE ARMY SM-1A STATIONARY MEDIUM POWER REACTOR. Richt, A. E.; Haynes, V. O. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 30p. Dep. NTIS.

Neutron-absorber element OM-2 was examined nondestructively after 35.6 MWyr of service in Cores II and III of the SM-1A Stationary Medium Power Reactor. The purpose of this examination was to determine if the element was dimensionally and structurally suitable for additional service. Through such periodic inspections and continuing operation, it is hoped to ultimately establish the maximum useful lifetime for this type of absorber element in the Army reactor systems. The element is composed of four composite absorber plates welded together to form a square, hollow tube. The stainless steel-clad absorber plates contain a dispersion of 37 wt % Eu_2O_3 in stainless steel as the neutron absorbing material. Results of the inspection indicated that the absorber element is in excellent physical condition. No significant structural damage was apparent visually, gamma scans showed no indications of abnormalities in the absorber burnup distribution, and the overall dimensions of the element appear to be well within acceptable limits. Consequently, these absorber elements are capable of performing satisfactorily for even longer periods of operation in the Army nuclear power plants. 7 references. (auth)

40385 IMPROVEMENTS IN NUCLEAR POWERED SHIPS. Rigg, Shepherd (to United Kingdom Atomic Energy Authority). British Patent 1,275,726. 24 May 1972. Filed 26 Aug 1968.

Reference is made to shielding arrangements in nuclear powered ships. The arrangement described provides emergency shielding without the actual installation of a physical shield in the ship, other facilities already existing in such a ship being adapted for the purpose. Use is made of the ship's collision barriers, which consist of chambers provided along the side of the ship that can accept collision impact and protect the reactor compartment. Inner and outer water-tight hulls are provided to form collision barriers along the port and starboard sides of the reactor, and a coffer dam extends across the ship forward of the reactor; means are provided for filling these with water to provide the shielding. Constructional details are given. (UK)

40386 PROPELLANT FLOW RATE THROUGH SIMULATED LIQUID-CORE NUCLEAR ROCKET FUEL BED. McGuirk, James P. (Univ. of Santa Clara, Calif.); Park, Chul. J. Spacecraft Rockets; 9: No. 5, 375-6(May 1972).

One of the concepts proposed for nuclear rockets consists of a reactor with molten liquid fuel. The liquid fuel is contained in rotating cylinders with porous walls. Gaseous propellant is bubbled through the walls, heated by the molten fuel, and expelled through a hole on the cylinder axis. Mockup studies on two-phase flow in a rotating cylinder under high rpm are described, and the measured results are compared to calculations. (H.D.R.)

40387 TWO-COMPONENT VORTEX FLOW STUDIES OF THE COLLOID CORE NUCLEAR ROCKET. Anderson, Loren A.; Hasinger, Siegfried H.; Turman, B. N. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Spacecraft Rockets; 9: No. 5, 311-17(May 1972).

Experiments with highly loaded solid-gas vortex flows are described. By application of end wall gas injection, solid to gas mass density ratios of the order of 100:1 have been obtained in the vortex with very small particle loss rates. Particle density distributions within the vortex were measured by x-ray absorption. Experimental data suggest a rotating fluidized bed model for the particle containment process. This concept is used to extrapolate present results to the aeromechanical design of a colloid core reactor suitable as a nuclear rocket engine. (15 references.) (auth)

40388 POTENTIAL OF NUCLEAR MHD ELECTRIC POWER SYSTEMS. Seikel, George R.; Nichols, Lester D. (Lewis Research Center, Cleveland). J. Spacecraft Rockets; 9: No. 5, 322-6(May 1972).

MHD generators are uniquely capable of fully exploiting advances in high-temperature reactor technology for electric power generation. Extension of NERVA technology could make 2500°K long-life, inert, gas-cooled reactors feasible. Such reactors and MHD generators mate into attractive multi-MW electric power systems for either space or ground applications. A turbo-MHD system using a turbine driven compressor is the most attractive cycle. It has high-cycle efficiency and low-radiator area and temperature for space applications. A space-power system with 10 MW electric output, shielded for manned missions, could achieve specific masses of 3.5 to 5 $\mathrm{kg/kW_e}$. A ground power station with 60% efficiency also appears feasible. 14 references. (auth)

40389 NERVA: SPACE FLIGHT BY NUCLEAR PROPULSION. Weltraumfahrt Raketentech.; 22: No. 1, 5-10(1971). (In German).

A description is given of the characteristics of nuclear rocket propulsion based on a comparison of nuclear propulsion and chemical propulsion. A short review is given of the hitherto prevailing efforts, followed by a discussion of the most recent result, the NERVA-reactor XE. This reactor generates thrust by using only one propellant ingredient (hydrogen). The possibilities of future applications are shown by giving some examples from the field of space flight. (INIS)

40390 NUCLEAR POWERED SHIPS. Rigg, Shephard (to United Kingdom Atomic Energy Authority). U. S. Patent 3,659,541. 2 May 1972. Priority date 26 Aug 1968, Great Britain.

A nuclear powered ship has its collision barriers made water tight and means are provided for filling the barriers with water to act as a shield against radiation in the event of, or as a precaution against, a "maximum credible accident," thus avoiding the need for a permanent shield outside the reactor containment vessel. Coffer dams in the ship can be similarly treated to give protection to the ship's crew. The means for filling the barriers may be a ring main pipe with access fore and aft of the ship or the ship's ballast system may be adapted to provide the filling water for the barriers. (Official Gazette)

Process Heat and Desalination Reactors

Refer also to abstract 38218.

Research and Test Reactors

Refer also to abstracts 38545, 40203, 40227, and 40448.

40391 (ANL-7919) RATE-LIMITED MODEL OF MOLTEN FUEL/COOLANT INTERACTIONS: MODEL DEVELOPMENT AND PRELIMINARY CALCULATIONS. Cho, D. H.; Ivins, R. O.; Wright, R. W. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 31p. Dep. NTIS.

A model of molten-fuel/coolant interactions is developed that incorporates various limiting rate processes. Essentially, two competing processes are involved: the heating of coolant by the fuel (which produces pressures) and the expansion of the heated coolant (which reduces pressures) against a constraint given by the surroundings. The coolant heating depends on the complicated processes of fragmentation and mixing as well as on the heat-transfer mechanisms. Preliminary calculations of pressure generation and voiding histories are made considering a 35-cm-long molten zone in an FFTF subassembly. Two different approximations are used for the heating process, and the results are compared. Both acoustic and inertial formulations are considered for the constraining effects of the unheated coolant external to the fuel-coolant mixing zone. 8 references. (auth)

40392 (CNEA-305) TRIFIDO: CODE FOR CALCULATION OF KINETIC PARAMETERS IN EXPERIMENTS WITH PULSED NEUTRONS. Difilippo, F.; Pieroni, N. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1971. 37p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The code calculates decay constant and the population of the fundamental prompt neutron mode extrapolated to initial time, using pulsed neutron experimental data. This data is the resulting time profile of the neutron density of a subcritical multiplicative assembly which is repetitively pulsed with short bursts of neutrons. With the calculated parameters the code determines the values of $k\beta/L$ and reactivity by means of the Garelis–Russell method, and reactivities using the Gozani and Sjöstrand methods. The unusual feature of TRIFIDO is that it calculates all these kinetic parameters in just one computer run. In order to provide a visual checking, the code draws a graph of the experimental data—corrected by noise and dead time effects—and fitted values. (auth)

40393 (HEDL-TME-71-15) ANALYSIS OF FTR PHASE B CRITICAL EXPERIMENTS. PART 5. ZPPR 1 (ASSEMBLIES FTR-1 AND FTR-2). Omberg, R. P.; Bennett, R. A.; Nelson, J. V. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1971. Contract AT(45-1)-2170. 52p. Dep. NTIS.

An analysis of the results of the second series of Phase B experiments in support of the Fast Flux Test Facility Critical Experiments Program is presented. The object of the Critical Experiments Program is to provide experimental data for evaluating the calculational methods currently used in the design of the Fast Test Reactor. The experiments were performed in the Zero Power Plutonium Reactor. The purpose of the phase was to measure the worth of large segments of a peripheral control ring located at the core-reflector interface. A comparison between calculation and experiment shows that the current calculational methods provide a sound basis for design, however, further investigation is needed to eliminate the discrepancies that exist. 18 references. (auth)

40394 (HEDL-TME-71-21) FAST FLUX TEST FACILITY WELDING STANDARDS FOR THE DRIVER FUEL ASSEMBLY. Crawford, R. M.; Brown, W. F. (Hanford Engineering Development Lab., Richland, Wash.). Feb 1971. Contract AT(45-1)-2170. 27p. Dep. NTIS.

The requirements for welding, examining, and testing welds for the FFTF Driver Fuel Assembly and irradiation test pins are described. The driver fuel assembly consists of an array of fuel pins fabricated into a fuel duct with other related fittings and hardware. The fuel pin array is structurally supported to provide proper spacing for sodium coolant flow in the fuel duct during irradiation. The individual fuel pins consist of nuclear fuel pellets encapsulated in stainless steel tubes with closure welds at each end of the tube. The driver fuel duct is a stainless steel hexagonal tube with welded end fittings which positions and supports the fuel pin subassembly in the FTR core. (auth)

40395 (HEDL-TME-71-90) FFTF OUTLET REGION FEATURE MODEL. FINAL REPORT ON ALL AIR ENTRAINMENT TEST SERIES. Spalek, J.; Ballard, D. L.; Sweetin, L. R. (Hanford Engineering Development Lab., Richland, Wash.). May 1971. Contract AT(45-1)-2170. 155p. Dep. NTIS.

A series of air entrainment tests was performed on the Outlet Feature Model of the FFTF during the period from October 1969 to June 1970. The geometrically scaled model used water as the modeling medium. Similarity analysis, using principally the Froude and Weber numbers, was performed to relate the test results to the FFTF sodium coolant. Visual and ultrasonic techniques were used to study the air entrainment in the reactor model outlet pool and carry-under into the coolant exit pipes. The model configuration and coolant pool height were varied to determine their effect on air entrainment. The test results established the optimum elevation of the outlet nozzles, and the minimum pool height that allows operation without air entrainment. The final configuration with the vortex suppression plate in place reduced air entrainment to zero. (37 references) (auth)

40396 (HEDL-TME-71-125(Rev.1)) FFTF DESIGN FLEXIBILITY FOR HYPOTHETICAL ACCIDENT MITIGATION. Peterson, R. E. (Hanford Engineering Development Lab., Richland, Wash.). 25 Oct 1971. Contract AT(45-1)-2170. 20p. Dep. NTIS.

The capability of the Fast Flux Test Facility (FFTF) containment to withstand consequences associated with a hypothetical core disruptive accident (HCDA) is investigated over a wide range of energy release. Responses of the primary coolant system boundary, the reactor cavity and the containment building to a theoretically available work energy of 150 MW-seconds are evaluated. The sensitivity of the design to work energy was also assessed by extending the calculations to 350 MW-seconds. The design is evaluated for higher energy releases up to 1000 MW-seconds. In these evaluations responses of the following design features were analytically obtained: reactor vessel head, reactor cavity pressures with and without vapor bubble collapse, piping interferences, plugs in the reactor vessel head, head compartment pressure sensitivity to postulated sodium release, reactor and guard vessel, and reactor support system. (auth)

40397 (HEDL-TME-72-51) FABRICATION OF AN INSTRUMENTED FTR FUEL ASSEMBLY FOR VIBRATION TESTING. Myers, R. L.; Sawtelle, G. K. (Hanford Engineering Development Lab., Richland, Wash.). May 1972. Contract AT(45-1)-2170. 83p. Dep. NTIS.

A prototypic instrumented FTR driver fuel assembly is described. This prototypic fuel assembly was fabricated to investigate potential fuel failure modes in actual fuel assemblies that might arise from flow-induced vibrations. The initial fabrication and assembly of the prototypic fuel assembly is discussed, along with special techniques and procedures developed in support of fabrication; test requirements; and inspection and modification to the original fabricated fuel assembly. Preliminary results from initial testing show sufficient performance and correlation between the different types of instrumentation to provide valuable vibration test data for the designer of FTR driver fuels. (auth)

40398 (HEDL-TME-72-52) STREAMING ANALYSES FOR THE FTR FISSION GAS PLENUM REGION. Boulette, E. T. (Hanford Engineering Development Lab., Richland, Wash.). May 1972. Contract AT(45-1)-2170. 31p. Dep. NTIS.

Results of parametric multigroup Monte Carlo analyses are presented to indicate that a homogeneous representation of the FTR fission gas plenum region is adequate for calculating the neutron attenuation characteristics of the plenum region. Coupled with two-dimensional diffusion theory adjoint calculations, the Monte Carlo results also demonstrate that a heterogeneous representation of the plenum region is unnecessary for establishing the radiation level above the FTR cover shield. (5 references) (auth)

40399 (INR-1381) BURNUP CALCULATIONS OF THE EWA-10 REACTOR. Apostolow, Tichomir; Kowalska, Krystyna (Institute of Nuclear Research, Warsaw (Poland)). 1972. 55p. Dep. NTIS (U. S. Sales Only).

Applicability of reactor codes for burnup calculations was tested. Some information concerning reactor operation and fuel strategy was obtained in a series of one- and two-dimensional, two- and multi-group calculations of the EWA-10 Reactor. Comparison of calculated and measured flux distributions led to a satisfactory agreement. (17 references) (auth)

40400 (INR-P-1354) EXPERIMENTS IN THE REACTOR "OSIRIS." Stanek, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1971. 183p. (In Polish). Dep. NTIS (U. S. Sales Only).

Since it was started up at the end of 1966, the swimming-pool research reactor OSIRIS has been used for numerous and varied irradiation experiments which have necessitated the development of a certain number of specially adapted experimental devices. A brief summary is given of the main characteristics of the reactor from the point of view of its use for experiments; the general experience acquired over three years is then described, and an explanation given of the organization of the work involved for an experiment from the initial project up to the placing of the device in the reactor. A detailed description is given of the main irradiation devices available: simple capsules such as those used for producing transuranic elements, temperature-controlled capsules fitted with instruments for carrying out creep tests or for following in-pile changes in certain characteristics of a sample, and complex loops with independent fluid circulation reproducing the ambient condition of power reactors. (20 references) (auth)

40401 (KURRI-TR-97) ON THE IN-CORE IRRADIATION LOOP OF THE KYOTO UNIVERSITY REACTOR. Kawata, Tomio; Murakami, Toru; Araki, Yasusuke; Sagane, Toshimitsu; Kimura, Itsuro; Shibata, Toshikazu (Kyoto Univ. (Japan). Research Reactor Inst.). [1971]. 10p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Details about a newly installed irradiation loop in the core of the Kyoto University Reactor, KUR, are described. This loop was designed for irradiation of an instrumented capsule of about 6 cm in diameter and about 30 cm long. Thermal and fast neutron flux at the capsule are about 2.3×10^{13} and 7×10^{12} n/cm^2/sec respectively. By making use of a capsule with a vacuum thermal shield and by controlling flow rate of carbon dioxide gas loop, irradiation temperature can be kept constant. As an example, the result of irradiation of boronated graphite samples is given. (7 references) (auth)

40402 (ORNL-TM-3786) FAST REACTOR SHIELDING, ACTIVITY NO. 40 01 61, 189A NO. 10028. Monthly Progress Report, February 1972. Mynatt, F. R.; Gritzner, M. L.; Maerker, R. E.; McGregor, B. J. (Oak Ridge National Lab., Tenn.). 7 Apr 1972. 38p. Dep. NTIS.

Activities during the month of February 1972 include: FFTF studies; pipe chase experiment; Na benchmark experiment; iron benchmark; and pipe chase streaming experiment. (D.C.C.)

40403 (ORNL-TM-3836) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JANUARY-MARCH 1972. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). 4 May 1972. Contract W-7405-eng-26. 41p. Dep. NTIS.

The ORR operated 2,044 hours or 93.6% of the time during January, February, and March of 1972. The power level during operation averaged 30.0 MW, indicating operation free of power reductions. Fuel utilization continued to be satisfactory with burnup averaging 52.1%. The quality of the coolant water was maintained at a satisfactory level. The reactor was shut down only eight times during the quarter, and only two shutdowns were unscheduled. Approximately 87% of the total downtime was utilized for experiment work and refueling, Most of the instrumentation, process equipment, and mechanical devices throughout the reactor complex operated as designed, requiring only routine maintenance. One exception worthy of note was the malfunction of the radiation instrumentation for the pressurizable off-gas system which resulted in false high radiation signals in several other radiation channels. The trouble, however, was remedied by the addition of an electrical shield which prevents interaction between channels. The reactivity worths of shim rods Nos. 3 and 5 were measured to determine the effect of the shim-rod-rotation schedule which was started in August, 1971. Two incident reports, Nos. 72-3 and 72-4, were issued. (auth)

40404 (ORNL-TM-3854) BULK SHIELDING FACILITY QUARTERLY REPORT, JANUARY-MARCH 1972. Tabor, W. H.; Hurt III, S. S.; Lance, E. D. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 49p. Dep. NTIS.

The BSR operated at an average power level of 1,742 kW for 33.2% of the time during January, February, and March. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There was one unscheduled shutdown during the quarter. The BSR was operated at low and variable power during the quarter for 68.7 hrs as a training aid for 20 trainees from the Tennessee Valley Authority (TVA) Browns Ferry nuclear power reactor. The PCA was operated during the quarter as follows: ten days as a training aid for trainees from the Tennessee Valley Authority Browns Ferry nuclear power reactor and three days as a training aid for students from the Nuclear Engineering Department of the University of Tennessee. (auth)

40405 (ORNL-TM-3857) FAST REACTOR SHIELDING MONTHLY PROGRESS REPORT FOR APRIL 1972, 189A NO. 10028, ACTIVITY NO. 40 01 61. Mynatt, F. R.; Gritzner, M. L.; Maerker, R. E.; McGregor, B. J. (Oak Ridge National Lab., Tenn.). Jun 1972. Contract W-7405-eng-26. 14p. Dep. NTIS.

Activities during the month of April 1972 include: FFTF studies; and pipe chase experiment. (D.C.C.)

40406 (WARD-2171-7) ANALYTICAL EVALUATION OF FUEL FAILURE PROPAGATION FOR THE FAST FLUX TEST FACILITY. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Dec 1970. Contract AT(45-1)-2171. 164p. Dep. NTIS.

The margin of safety that is designed into the Fast Flux Test Facility with respect to fuel failure propagation is analyzed. The criterion selected for this demonstration is the capability of the design to prevent possible fuel element failure in a single affected driver fuel subassembly from causing fuel element failure in neighboring driver fuel subassemblies. To meet this objective a realistic appraisal was made of the major fuel failure and failure propagation phenomena of concern in liquid metal cooled fast reactors. (65 references) (auth)

40407 (WARD-3684-5) EVALUATION OF COMPLIANT GRID-TYPE FUEL ROD SPACERS FOR FTR FUEL ASSEMBLY. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Nov 1968. Contract AT(30-1)-3684. 233p. Dep. NTIS.

The study objective was to develop a conceptual design for a compliant grid type fuel pin spacer for use in the FFTF fuel assembly. Three basic grid designs were considered: (1) tri planar tubular grid; (2) honeycomb grid; and (3) clustered rod grid. All three grid designs incorporated a new type of spring finger design using a torsion bar as the principal spring element. The honeycomb grid was selected as having the best mechanical and thermal hydraulic characteristics. The mechanical and thermal fluidic analysis leading to the selection of the honeycomb grid is presented. The performance of a fuel assembly incorporating these grids is assessed. Development programs are given detailing the principal design and development activities required to produce a successful fuel assembly, incorporating compliant grid pin spacers. (76 references) (auth)

40408 (WARD-3684-5(App.)) EVALUATION OF COMPLIANT GRID-TYPE FUEL ROD SPACERS FOR FTR FUEL ASSEMBLY. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Nov 1968. Contract AT(30-1)-3684. 379p. Dep. NTIS.

Computer programs used in the stress analysis for FTR fuel element spacers are presented. Spring finger analysis and flow induced vibrations of the fuel rod are studied. (D.C.C.)

40409 FUTURE FOR THE ESSOR PLANT. Bonnaure, P. (European Atomic Energy Community, Ispra, Italy). Nucl. Eng. Int.; 17: No. 192, 405-9(May 1972).

Modifications to the organic cooled research reactor ESSOR for use as a multipurpose irradiation facility for the development of fuel elements and large components for light water, heavy water and high temperature reactors are described. Details are given of the reactor facilities and experimental installations including irradiation facilities and water loops. Suggestions are made regarding other future applications of the reactor. (UK)

40410 LATTICES OF PLUTONIUM-ENRICHED RODS IN LIGHT WATER. I. EXPERIMENTAL RESULTS. Uotinen, V. O.; Lauby, J. H.; Schmid, L. C.; Stinson, W. P. (Battelle-Northwest Labs., Richland, Wash.). Nucl. Technol.; 15: No. 4, 257-71(Aug 1972).

Results of experiments conducted in the Critical Approach Facility are presented for a total of 48 lattices of plutonium-enriched rods. Five kinds of UO_2-PuO_2 rods ranging in PuO_2 enrichment from 1.5 wt% to 4.0 wt%, and three kinds of Al−Pu rods ranging in Pu enrichment from 1.8 wt% to 5.0 wt%, were used in the experiments. The lattices covered a broad range of water-to-rod volume ratios. Parameters reported for each lattice are: the number of rods required for a critical loading, the relaxation length measured in an exponential loading, the critical buckling and reflector savings. For five of the lattices results are also reported of the worth of central absorber rods of boron and hafnium. The results of approach-to-critical experiments were verified by comparing them with the results of critical measurements conducted in three lattices. (34 references) (auth)

40411 LATTICES OF PLUTONIUM-ENRICHED RODS IN LIGHT WATER. II. THEORETICAL ANALYSIS OF PLUTONIUM-FUELED SYSTEMS. Liikala, R. C.; Uotinen, V. O.; Jenquin, U. P. (Battelle-Northwest Labs., Richland, Wash.). Nucl. Technol.; 15: No. 4, 272-96(Aug 1972).

A theoretical analysis of UO_2-PuO_2 fueled, light water moderated lattice experiments was performed to aid in establishing technical bases and design criteria for the utilization of Pu bearing fuel in thermal power reactors. Results for UO_2 and Al−Pu lattices are included to understand the effects due to U and Pu separately. The problems involved in calculating critical experiments are discussed. Estimates of the effects of various approximations inherent in the theoretical methods and/or analysis procedures are included along with the consequence on the results of the correlation. Uncertainties in the measurements and the neutron cross-section data are related to uncertainties in the calculated values of k_{eff}. Areas which should be investigated in future analyses are also identified. (auth)

40412 FUEL IRRADIATION WITH EXPERIMENTAL CAPSULE INSERTIONS INTO THE FR-2 REACTOR. Haefner, H. E. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 6, 314-15(Jun 1972). (In German).

Since 1965, approximately 300 test fuel rods were irradiated in the FR-2 research reactor. Six different types of capsules were used. Specifications of these types were tabulated as to number of fuel rods, fuel, dimensions, power, capsule surface temperatures, and burnup. During the entire irradiation program, no operational disturbance occurred which might have endangered personnel, reactor, or environment. (H.B.G.)

40413 HIGH FLUX FRANCO-GERMAN REACTOR. INTEGRATED EQUIPMENT FOR NUCLEAR PHYSICS EXPERIMENTS. Faudou, J. C. (Institut Max von Laue-Paul Langevin, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 166, 27-33(Jan 1972). (In French).

Special apparatus is used in conjunction with the reactor for nuclear physics experiments. The apparatus is used to place the sample in the reactor channel in such a way as to facilitate the extraction of the beam produced as a result of neutron capture by the sample. Three different types of apparatus are employed depending upon the nature of the extracted beam: fission product beam emitted by a uranium source; a γ ray capture beam emitted by an isotope; an internal conversion electron beam emitted by an isotope. The technical problems studied during the development of these systems are presented. (France)

40414 HIGH FLUX FRANCO-GERMAN REACTOR. HOT SOURCE OF THE HIGH FLUX REACTOR. Bohme, G. (Gesellschaft fuer Kernforschung mbH., Karlsruhe, Ger.); Wunderlich, F.; Drexel, W. Bull. Inform. Sci. Tech. (Paris); No. 166, 23-6(Jan 1972). (In French).

To achieve a gain in hot neutron flux (0.15 to 1 eV) for 4 HFR channels, a hot source was set up in the heavy water reflector. This source consists of a graphite block heated to 20000°K by nuclear radiation. It is surrounded by graphite wool and insulated from the heavy water by a double shielding. The safety of the unit is ensured by the monitoring of the pressures in the He circuit together with certain built-in safety measures. (France)

40415 HIGH FLUX FRANCO-GERMAN REACTOR. PLANNING AND OPERATIONAL COSTS. HIGH FLUX REACTOR. Chatoux, J. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 166, 59-60(Jan 1972). (In French).

The principal dates associated with the planning of the system are recalled. A brief analysis of the costs involved is presented: construction costs; costs of nonintegrated experimental equipment; expenses incurred by the Max Von Laue−Paul Langevin Institute. Provisions for economic changes are included. (France)

40416 HIGH FLUX FRANCO-GERMAN REACTOR. ORGANIZATION AND OPERATION. Droulers, Y. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 166, 55-7(Jan 1972). (In French).

The organization involved in the reactor service concerned with starting-up procedures is presented. The sharing of particular responsibilities during the running of the reactor is emphasized. (France)

40417 HIGH FLUX FRANCO-GERMAN REACTOR. AUTOMATIC HANDLING OF EXPERIMENTAL DATA. Teaschner, M. (Institut Max von Laue-Paul Langevin, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 166, 53-4(Jan 1972). (In French).

Most of the experiments envisaged by the Max Von Laue−Paul Langevin Institute involve the utilization of computers for the control and supervision of experiments, the collection of data, and the checking and pretreatment of data. The computer facilities available are: two T 2000 computers (CARINE system), and two T R 86 computers (NICOLE system). Certain experiments are equipped with small computers (PDP 11). (France)

40418 HIGH FLUX FRANCO-GERMAN REACTOR. NUCLEAR PHYSICS SPECTROMETERS. Faudou, J. C. (Institut Max von Laue-Paul Langevin, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 166, 49-52(Jan 1972). (In French).

Three spectrometers were designed for nuclear physics research. Two of these spectrometers are used to analyze charged particles after having focused the beam by ion optical systems, the particles being either nonattenuated fission products or conversion electrons. The third type of spectrometer analyzes thermal neutron capture γ rays separating the energies by reflection from curved crystals. (France)

40419 HIGH FLUX FRANCO-GERMAN REACTOR. SOLID STATE PHYSICS SPECTROMETER. Gobert, G. (Institut Max von Laue-Paul Langevin, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 166, 41-8(Jan 1972). (In French).

Spectrometers currently envisaged for use in conjunction with the reactor are designed according to standard technology and possess mechanical features dependent upon the requirements sought. The large number of possible combinations and permutations of equipment give these instruments great versatility. A few examples are given. (France)

40420 HIGH FLUX FRANCO-GERMAN REACTOR. NEUTRON DUCTS. Ageron, P.; Blum, P. A. (Institut Max von Laue-Paul Langevin, Grenoble, France). Bull. Inform. Sci. Tech. (Paris); No. 166, 35-9(Jan 1972). (In French).

Ten neutron ducts were installed. They are terminated by special ducts distributing the beams between the experimenters. They supply 40% of the available experimental facilities of the high flux reactor. The principles are briefly discussed and the manufacturing tolerances imposed concerning the microscopic roughness of the surface, macroscopic angular defects (angular adjustment and flatness of the elements) and shock defects are presented. The building arrangements are dependent upon the path of ducts, which leave the pile building, pass through the swimming pool and a concrete cell, and emerge, either in the experimentation hall of the reactor or in an adjoining building. (France)

40421 CRITICAL EXPERIMENTS WITH HOMOGENEOUS PuO_2-POLYSTYRENE AT 50 H/Pu. Bierman, S. R.; Clayton, E. D. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 15: No. 3, 5-13(Jul 1972).

The results and analyses are presented from a series of experiments for determining the critical parameters of plutonium mixtures over the under-moderated region of the neutron energy spectrum. This series of experiments was conducted with PuO_2-polystyrene fuel having an atomic H/Pu ratio of 49.6 and a ^{240}Pu isotopic content of 18.35 wt %. In addition to providing basic criticality data, the experiments were designed to: (1) establish the degree of correlation between the PuO_2-polystyrene and the plutonium nitrate solution fueled critical experiments performed at the Hanford Critical Mass Laboratory, (2) provide data for checking previously reported differences obtained by the neutron diffusion theory code HFN and the neutron transport theory code DTF-IV in calculating critical sizes of plutonium-water systems between about 500 and 1000 g Pu/liter, (3) substantiate that high exposure, subcritical, fixed volume, Pu-water systems can be made critical by dilution with water. In contrast to the data previously obtained on this same PuO_2 material unmoderated, the density effect of having the plutonium in the oxide form was found to have essentially no effect on the reactivity at 49.6 H/Pu. At 49.6 H/Pu, the minimum critical slab thickness was determined to be 5.22 ± 0.07 cm for ^{239}Pu-water as compared to 5.34 ± 0.07 cm for $^{239}PuO_2$-water. However, the neutron poisoning effect of the ^{240}Pu at 49.6 H/Pu was at least five times that observed for the PuO_2 unmoderated. At this near-optimum concentration for maximum ^{240}Pu effects, the percent change in spherical critical mass per percent change in ^{240}Pu content was determined to be 12.1 for the reflected case and 10.2 for the bare case. Based on the data derived from these experiments at 49.6 H/Pu, the HFN code was found to accurately calculate the Pu-water systems at 521 g Pu/liter and should be used at this and lower concentrations in preference to the DTF-IV code for calculating critical parameters. As with the plutonium nitrate solutions at high concentrations, the DTF-IV neutron transport theory code calculations resulted in too small a critical size; however, the data obtained from the PuO_2-polystyrene experiments correlated well with those that have been obtained from plutonium nitrate solutions. The experiments also showed that, for high exposure Pu-water systems, a given size vessel could be just critical ($k_{eff} = 1.0$) at three different concentrations below about 1000 g Pu/liter. Consequently, a critically safe vessel could be made critical by dilution alone if the ^{240}Pu content was high enough. 13 references. (auth)

40422 OPTIMIZATION OF REACTOR CONTROL SYSTEM BY USING RANDOM NOISE. Koh, Byung Joon; Shin, Jae In. J. Korean Inst. Electron. Eng.; 6: No. 1, 1-11(1969). (In Korean).

Reactor power frequency spectrum measurements at various power levels were made with TRIGA-MARK-II. An ion chamber was exposed to reactor flux, and the fluctuations in its output current were analyzed in a tunable bandpass filter to get the frequency spectrum of these fluctuations. The measured frequency spectrum of the pile determined the zero power transfer function and indicated a prompt neutron mean life time of (7.90 ± 1.62) × 10^{-5} sec based on effective delayed neutron fraction of 0.0075. The absolute value of reactor power obtained by noise analysis agreed within 5% with the power meter indication at the power below 10 kW. (Korean Sci. Abstr.)

Production Reactors

40423 (HW-83339-RD) PROPOSED OPERATING LIMITS PROCESS TUBE FLOW AND OUTLET TEMPERATURE. Danekas, G. N.; Shoemaker, R. H. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 17 Jul 1964. 16p. Dep. NTIS.

Declassified 2 Nov 1971.

Interim process tube flow and outlet temperature limits for a power ascension test of the N Reactor are presented. (H.D.R.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 38366, 38464, 38811, 38813, 38814, 38828, 38876, 38880, 38906, 38923, 38924, 38934, 38943, 38971, and 38995.

40424 (RDT-E-7-8-T(4-72)) PENETRATIONS FOR PIPING. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 31p. RSO.

The basic requirements are established for design, fabrication, cleaning, handling, marking, packaging, shipping and quality assurance of pipe penetration assemblies. The standard is applicable to pipe penetration assemblies used as a continuation of a process pipe through a wall or bulkhead which is required to be internally or externally sealed such as a nuclear containment vessel or a gas tight lined cell. (auth)

40425 (ZJE-114) TEMPERATURE FIELD MEASUREMENT IN THE REGION OF SPACING ELEMENTS. Krett, V.; Majer, J. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 32p. Dep. NTIS (U. S. Sales Only).

The results of measurements of temperature fields in the region of fuel elements spacing grids are described, the results of measurements obtained by different authors are compared, the influence of longitudinal temperature gradients are analyzed, and how the results of measurements carried out on test rods are to be recalculated to actual fuel rods is explained. The method of recalculation is based on mathematical solution of the temperature field in the test and in the actual rod. The fuel assembly used consists of a bundle of smooth and finned rods. (11 references) (auth)

40426 NUCLEAR REACTOR CHARGE/DISCHARGE ARRANGEMENT. Blunt, Francis Ivor (to British Nuclear Design and Construction Ltd.). British Patent 1,273,977. 10 May 1972. Filed 4 Jul 1968.

The arrangement described has particular application to fluid-cooled reactors in which the core is built up from a number of vertical columns, some of which have fuel channels from which fuel elements may be withdrawn and replaced through standpipes in the pressure vessel. The arrangement includes a guide tube supported on a cable or similar flexible member and of length sufficient to accommodate the complete length of a column. The cable is connected to a probe within the guide tube, the lower end of this probe having a latching device, the arrangement being such that to withdraw a selected column the guide tube is passed through the appropriate standpipe and aligned over the column; the lower edge of the guide tube is then brought into contact with adjacent columns so as to urge the latter away from the selected column, and the cable is lowered to lower the probe so that its latching device engages the lower end of the column; the cable is then raised to lift the columns into the guide tube for removal from the reactor. Replacement is the reverse of the withdrawal procedure. The columns are preferably arranged in groups each of which comprises a number of columns arranged with their axes at a constant radius from a central point in vertical alignment with a standpipe. In this case the guide tube is articulated to a rotatable support tube, and a mechanism is provided for moving the guide tube between a retracted position within the support tube and on extended position radially offset from the support tube, the arrangement being such that a selected column may be serviced by appropriate rotation of the support tube. (UK)

40427 IMPROVEMENTS IN LIQUID COOLED NUCLEAR REACTOR PRESSURE VESSEL. Rigg, Shepherd (to United Kingdom Atomic Energy Authority). British Patent 1,273,559. 10 May 1972. Filed 8 Aug 1968.

Reference is made to reactors in which the core is housed in a pressure vessel surrounded by an outer containment. In the arrangement described the outer containment includes a coolant reservoir together with a duct linking the reservoir with the interior of the pressure vessel and a valve adapted to open in the event of pressure in the outer containment exceeding a datum pressure, due to pressure vessel failure and loss of coolant from the reactor core. This valve is preferably immersed in a pool of coolant in a plenum between the pressure vessel and the outer containment with the liquid level in the pool above the reactor core in order to provide shielding during normal operation of the reactor and to allow liquid to flow from the pool into the core under a gravity and convection head on opening of the valve. A further valved duct may be provided in the top of the pressure vessel, this valve being openable either by ambient pressure in the outer containment or by over-pressure in the pressure vessel. Opening of this second duct by over-pressure in the pressure vessel increases the pressure in the outer containment and causes the valve in the duct from the pool to the pressure vessel to open. (UK)

40428 INSTALLING SURFACE TEMPERATURE THERMOCOUPLES IN MODEL FUEL PINS. Burnett, P. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Nucl. Eng. Int.; 17: No. 192, 401-4(May 1972).

Tests were carried out on a model fuel pin fitted with an internal current carrying copper bus-tube, using internal thermocouples attached by three different methods. Thermocouples spot welded to the inside wall of the pin measured substantially the same temperature whether the bus-tube was generating heat or not. Thermocouples brazed into the wall, with leads passing inside the bus-tube, showed an error amounting to 5–10% of the bus-tube/pin temperature difference. Thermocouples mounted in silicone rubber and held against the inside wall by the elasticity of the rubber showed an error of 35–40% of the bus-tube/pin temperature difference. When a radial temperature gradient existed within the pin, even though the bus-tube was not generating heat, errors of approximately the same magnitude were observed. (auth)

40429 PLUTONIUM AND FISSION PRODUCT REDISTRIBUTION IN MIXED-OXIDE FUELS DURING IRRADIATION. Bahl, J. K. (Bhabha Atomic Research Center, Bombay); Freshley, M. D. Nucl. Technol.; 15: No. 4, 114-24(Aug 1972).

Plutonium and fission product migration were studied in a low burnup vibrationally compacted UO_2-2 wt% PuO_2 specimen utilizing autoradiography, microsampling, microgamma scanning, and shielded electron microprobe analytical techniques. The results show that a significant change in radial plutonium concentration can occur rapidly in high performance mixed-oxide fuels by a vapor transport mechanism that is coincident with the fuel restructuring phenomenon. This results from the condensation of uranium-rich vapor in the cooler peripheral regions of the fuel rod. Cesium, ruthenium, and rhodium migrate significantly in mixed-oxide fuels, whereas zirconium, niobium, cerium, and praseodymium do not redistribute significantly. (auth)

40430 RADIAL PORE DISTRIBUTION IN SHORT-TERM IRRADIATED TEST FUEL RODS. Hoffmann, H.; Hellriegel, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 6, 317-18(Jun 1972). (In German).

Because of the porosity dependency of heat conduction, radial pore distribution in fuel elements affects the temperature distribution in the fuel. Shape and orientation of the pores also affects thermal conductivity. For mathematical treatment of fuel rod behavior in reactors, quantitative models for pore migration were developed. Through a comparison between calculated and experimentally determined pore distributions, the validity of various models for pore migration was examined. (H.B.G.)

40431 NUCLEAR REACTOR SPRING FERRULE SPACER GRID. Krawiec, Donald M. (to Combustion Engineering, Inc.). U. S. Patent 3,664,924. 23 May 1972. Filed 24 Jun 1968.

A bimetallic spacer grid for nuclear reactors comprises a plurality of spacer elements and spring ferrules which are mated to form the grid assembly. The spacer elements are comprised of a material having a characteristic low neutron capture cross section and are formed with outwardly extending arches while the spring ferrules are formed from a material which has better stress relaxation qualities than the material employed for the spacer elements and which will thus not suffer a substantial decrease in resiliency due to prolonged exposure to intensive radiation. The spring ferrules and spacer element arches cooperate to support each fuel element at five points of contact. (Official Gazette)

40432 FUEL SUBASSEMBLY FOR NUCLEAR REACTOR. Friedland, Aaron J. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,661,708. 9 May 1972. Filed 9 May 1968.

A fuel subassembly for a nuclear reactor includes a wrapper tube and an upper and lower core bundle assembly contained therein, one of the core bundle assemblies being connected to the wrapper tube in such a manner that when the temperature of the fuel subassembly increases said one core bundle assembly is axially displaced to a magnified extent with respect to the other core bundles assembly, and thus increases the negative feedback of the subassembly. (Official Gazette)

40433 APPARATUS FOR DENSITY DETERMINATIONS ON VERY SMALL SOLID SAMPLES. Cawthorne, C.; Sinclair, W. D. J. (Dounreay Experimental Reactor Establishment, Thurso, Scotland). J. Phys., E (London); 5: No. 6, 531-3(Jun 1972).

An Archimedes density apparatus using only standard laboratory apparatus and capable of the rapid determination of densities of samples weighing only 30 mg with repeatability better than ±0.05% is described. The apparatus is used for estimating induced voidage in nuclear reactor structures. (UK)

40434 NUCLEAR REACTOR UPPER CORE GRID. Dalke, Charles Arthur; Child, Cedric L. (to General Electric Co.). U. S. Patent 3,660,233. 2 May 1972. Filed 12 Nov 1969.

A fuel assembly top guide for the fuel core of a nuclear reactor includes screws having threads with an acute included angle between the thread pressure flank face and the screw axis for fastening the notched intersections of the beams forming the top guide. (Official Gazette)

40435 REACTOR CONTROL SYSTEM. Klingbeil, Herbert N.; Cliffe, Walter W.; Castell, William A. (to Canadian General Electric Co. Ltd.). U. S. Patent 3,660,229. 2 May 1972. Filed 7 Feb 1969.

A method of controlling the pressure in the primary circuit of a nuclear power plant in which the fluid in the primary circuit is liquid and the circuit has a surge tank and spray means for condensing vapors in the tank is described. The pressure in the primary circuit is controlled by controlling the spray means in response to the pressure in the secondary circuit. (Official Gazette)

40436 INTERLOCKED ASSEMBLY OF BLOCKS FOR A NUCLEAR REACTOR MODERATING CORE. Banks, Robert (to United Kingdom Atomic Energy Authority). U. S. Patent 3,660,232. 2 May 1972. Priority date 21 May 1968, Great Britain.

A moderator structure is provided wherein bodies of moderator material are stacked in layers to provide juxtaposed columns. The bodies are each provided with splines which have side faces lying in planes passing through the longitudinal axis of the body. Bodies in a given layer abut one another only by said side faces. (Official Gazette)

Reactor Physics and Core Engineering

Physics

Refer also to abstracts 38484, 38489, 40410, and 40411.

40437 (AECL–4155) MICRETE 4 USERS MANUAL. Appendix 1. McDonnell, F. N.; Tanner, C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar 1972. 29p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

A description is given of the CDC-6600 program, called MICRETE 4, which solves the two-dimensional two-group reactor lattice problem using the microscopic discrete theory. A brief summary of the theory is given along with all the instructions necessary to use the program. A complete listing of the MICRETE 4 input and output for a test case is included. (9 references) (auth)

40438 (AEEW–M–1048) UNITED KINGDOM APPROACH TO THE CALCULATION OF BURN-UP IN THERMAL REACTORS. Tyror, J. G.; Askew, J. R. (Atomic Energy Establishment, Winfrith (England)). Jul 1971. 22p. (CONF-710724–1). Dep. NTIS (U. S. Sales Only).

From IAEA panel on reactor burn-up physics; Vienna, Austria (12 Jul 1971).

The facilities available in the WIMS suite of codes for the calculation of depletion in lattice cell geometry are described. This level of representation is the most detailed in its treatment of nuclear data, and represents the "best" United Kingdom calculation which may be used alone or as a basis for adjustment of simpler models. The various levels of representation appropriate to reactor fuel management are discussed, including both explicit and implicit treatments of depletion. It is concluded that different calculational models may be appropriate to different reactor types. The implications of this in the design of computing schemes are indicated by reference to the WIMS-E compatible code scheme. Comparisons between WIMS results and measurements of isotopic changes in fuel irradiated in a range of reactor types demonstrates good agreement. (22 references) (auth)

40439 (BNL–16725) ANALYSIS OF HEAVY AND LIGHT WATER MODERATED THERMAL REACTOR LATTICES USING ENDF/B DATA AND THE HAMMER CODE SYSTEM. Rothenstein, Wolfgang (Brookhaven National Lab., Upton, N. Y.). Sep 1969. 48p. (RP–1001). Dep. NTIS.

An analysis of light and heavy water moderated thermal reactor lattices with the HAMMER code system and ENDF/B data led to values of k_{eff} for experimental lattices which are between one and two percent below unity. Among the factors which cause the low values of k_{eff} the value of α_{th} of ^{235}U and $\sigma_c(2200)$ of ^{238}U appear to be important since the ENDF/B data lead to more parasitic capture than the values used previously. (22 references) (auth)

40440 (CEND–3932-1-349) OPTIMUM SPATIAL FLUX CONTROL PROJECT: PHASE I. CEXE: A THREE-DIMENSIONAL NODAL METHOD FOR ANALYSIS OF XENON OSCILLATIONS AND CONTROL. Kern, Richard; Wright, David C.; Coppersmith, W. Carlton; Rosztoczy, Zoltan R. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). 31 May 1969. Contract AT(30-1)-3932. 140p. Dep. NTIS.

The CEXE Code incorporates a three-dimensional calculational method for the analysis of xenon-induced spatial power oscillations in large power reactors. It is based on modified one-group theory for the calculation of the neutron source distribution. Another code, INCEXE, was written for preparing a portion of the CEXE input. Both codes are written in FORTRAN IV for the IBM 360/65 computer. (8 references) (H.D.R.)

40441 (INR–1380) TIDEC: A ONE POINT DEPLETION AND FISSION PRODUCT PROGRAMME IN GIER ALGOL-4. Andrzejewski, Krzysztof (Institute of Nuclear Research, Warsaw (Poland)). 1972. 52p. Dep. NTIS (U. S. Sales Only).

TIDEC is a one point program for fuel depletion and fission product accumulation calculations. The method of linear chains and analytic solution of the differential equations of the isotope density change is applied. The program may use three fission product libraries of different length for the calculation of the fission products content. The operation of the program as well as its mathematical and physical background are described. The program listing and the input and output example are given. (auth)

40442 (INR–1382) STUDIES OF FAST FISSION FACTOR IN REACTOR LATTICES WITH MULTITUBE ENRICHED FUEL. Jozefowicz, Krystyna; Jozefowicz, Edward T. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 17p. Dep. NTIS (U. S. Sales Only).

The fast fission effect was studied experimentally and numerically in the reactor lattices containing multitube enriched fuel of WWR-SM, ANNA and MR types with different moderators (water, graphite, beryllium). The measurements of δ^{28} factor are performed using fission track detectors—Makrofol E foils in contact with depleted and natural uranium. The calculations involve simple fitting formulas with estimation of some effective cross sections. The (n,2n) reaction in beryllium is accounted for by collision probability considerations. (9 references) (auth)

40443 (LA-tr-72-13) TREATMENT OF THE SPACE DEPENDENCE OF ENERGY RESONANCE SELF-SHIELDING AT BOUNDARIES OF HOMOGENEOUS ZONES IN REACTORS. Huschke, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translated for Los Alamos Scientific Lab., N. Mex.), from report KFK–1353. 116p. Dep. NTIS.

The problem of space dependent resonance self-shielding at boundaries is investigated for the case of two half-spaces with different concentrations of resonant material. A formalism is developed which allows a description of this phenomenon, also at boundaries of narrow zones by using the f-factor tables of the existing cross section sets. For two assemblies the influence of space-dependent resonance self-shielding on important reactor parameters is investigated. (21 references) (auth)

40444 (RISO-M–1477) USER'S GUIDE TO THE RESAB PROGRAM SYSTEM FOR THE B6700 COMPUTER. Mikkelsen, J.; Kirkegaard, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar 1972. 82p. Dep. NTIS (U. S. Sales Only).

A revised description is given of the use of RESAB, an ALGOL program for calculation of resonance reactions in a reactor. This program was converted to match the B6700 computer and replaces the original version, which was described in RISO–M–1378. 9 references. (auth)

40445 (Y-DR–81) GRAPHITE AND POLYETHYLENE REFLECTED URANIUM-METAL CYLINDERS AND ANNULI. Mihalczo, J. T. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 28 Apr 1972. Contract W-7405-eng-26. 35p. Dep. NTIS.

Cylinders and cylindrical annuli of uranium metal (93.15 wt % ^{235}U), with diameters varying from ~7 to ~15 in., were assembled to delayed criticality with graphite reflectors varying in thickness up to 18 in. or with effectively infinite thickness polyethylene on all outer surfaces. In one series of measurements an effectively infinite thickness polyethylene was also placed adjacent to only one flat surface of the cylinders. The multiplication factor calculated by both S_n transport theory and Monte Carlo methods agreed very well with the experimental values. As a result of the high order of S_n and the large number of spatial intervals required, the computing time for the transport theory calculations was a factor of 10 larger than that required for the Monte Carlo calculations with standard deviations of 1%. (8 references) (auth)

40446 COMPARISON OF MODULATED SOURCE AND MODULATED POISON NEUTRON OSCILLATORS. Shani, G. (Univ. of the Negev, Beer-Sheva, Israel). Nucl. Instrum. Methods; 101: No. 3, 455-65(1972).

The two possible ways of neutron density modulation (neutron waves) in a nuclear reactor are compared. One method is reactivity modulation by modulation of the amount of poison seen by the core, and the second is modulation of thermalized neutrons from a ^{252}Cf neutron source. The design of the two oscillators in the core tank is described and results are presented. The analyzed data are compared with two group-time dependent calculations. It is concluded that the two methods yield near-identical results, except in the region of the oscillator itself where the modulated poison oscillator decreases the number of neutrons, while the modulated source oscillator increases the number of neutrons. 8 references. (auth)

40447 KINETIC PARAMETERS IN A PLUTONIUM LATTICE CONTAINING WATER REGIONS. Uotinen, V. O.; Stinson, W. P.; Singh, S. P. (Battelle-Northwest, Richland, Wash.). Nucl. Technol.; 15: No. 4, 109-13(Aug 1972).

Reactor noise techniques were used to determine how the quantity β_{eff}/l changes when water regions of several sizes and shapes are introduced into a light-water lattice of plutonium-enriched rods. The measured value of β_{eff}/l for the unperturbed uniform lattice was 89 ± 2 sec^{-1}. This value was reduced significantly as successively larger water regions were introduced into this lattice. Calculated values of β_{eff}/l obtained with a typical reactor design calculational method agree with measured results to within ±5% for these experiments. (19 references) (auth)

40448 MEASUREMENT OF k_∞ AND RELATIVE REACTION RATES IN AN H_2O-MODERATED UO_2-PuO_2 PARTICULATE FUELED LATTICE. Newman, Darrell F. (Pacific Northwest Labs., Richland, Wash.). Nucl. Technol.; 15: No. 4, 192-208 (Aug 1972).

The neutron multiplication factor, k_∞, and relative reaction rates were measured at room temperature in the Physical Constants Testing Reactor for a water moderated lattice fueled with Zircaloy clad UO_2-PuO_2 fuel rods. The plutonium content in different sets of fuel rods ranged from 0.9 to 2.5 wt% PuO_2 in UO_2. These experiments provide neutronics data for uniform lattices of mixed oxide fuels which contain plutonium oxide distributed throughout the uranium oxide as finite-sized particles. The PuO_2 particle sizes in different sets of fuel rods ranged between zero and 328 microns in diameter. Knowledge of the effect that plutonium particle size has on neutron multiplication is important for the economic utilization of plutonium. An experiment-theory correlation provides a basis for assessing the adequacy of calculational techniques. (29 references) (auth)

40449 SPECTRUM-AVERAGED CROSS SECTIONS DEDUCED FROM BURNUP DATA AND THEIR APPLICATION TO METHODS VERIFICATION. Schmid, L. C.; Christensen, D. E.; Duane, B. H.; Liikala, R. C.; Matsen, R. P. (Battelle-Northwest Labs., Richland, Wash.). Nucl. Technol.; 15: No. 4, 297-318(Aug 1972).

The determination of ratios of spectrum-averaged cross sections from isotopic concentrations is described along with their application to verification of analytical reactor design tools. The determination is made using specially developed least-squares computer programs which fit the mathematical transmutation relationships to isotopic concentrations measured in irradiation experiments. These data are utilized as a basis for evaluating the accuracy of calculational methods used to predict burnup behavior of nuclear fuels. Data obtained from irradiation experiments using plutonium-aluminum alloy fuel are given to illustrate the techniques and demonstrate how these data are used to verify calculational methods. (auth)

40450 DETERMINATION OF RATIOS OF EFFECTIVE CROSS SECTIONS FROM BURNUP DATA FROM THE SAXTON PLUTONIUM PROGRAM. Coudron, P. E.; Matsen, R. P.; Schmid, L. C. (Battelle-Northwest Labs., Richland, Wash.). Nucl. Technol.; 15: No. 4, 229-38(Aug 1972).

Isotopic data obtained from the destructive analysis of UO_2-6.6 wt% PuO_2 rods irradiated in Core II of the Saxton reactor were used to derive ratios of effective cross sections. Two sets of cross section ratios, corresponding to data from regions of the core with different neutron spectra, were developed. Selected cross-section ratios from the Saxton data were compared with those obtained from other reactors. (14 references) (auth)

40451 EFFECTIVE DIFFUSION COEFFICIENTS IN HETEROGENEOUS MEDIA. II. THE CYLINDRICAL CELL. Williams, M. M. R. (London Univ.). J. Nucl. Energy; 26: No. 4, 189-209(Apr 1972).

A general theory of anisotropic diffusion in a cylindricalized lattice cell is developed. The P_N equations are derived for the normal and tilted fluxes in the cell and are related to the effective axial and radial diffusion coefficients which are used in homogeneous diffusion theory calculations. The theory is applied to a two region, non-absorbing cell, and P_3 corrections to the axial diffusion coefficient are obtained. The case of a void by a special method involving an exact solution of the transport equation in the void region is also examined. The theoretical results are compared with those of Carter and of Benoist and also with some recent experiments of Bull and Connolly. (auth)

40452 OPTIMIZED OPERATION OF A XENON POISONED NUCLEAR REACTOR. Reynaert, M.; Van Cauwenberghe, A. R. (Ghent Rijksuniversiteit). Rev. A; 13: No. 4, 141-50(1971). (In Dutch).

High flux thermal reactors are excessively sensitive to xenon poisoning due to a sudden shut-down of the reactor. Because of a restricted reserve in reactivity, the restartup can take place only after a varying period of several hours to several days. With the purpose of shortening this period of non-activity, several shutdown programs, based on the Pontryagin principle, were studied. These calculations can be made easily with the aid of a computer. (tr-auth)

40453 SOME DEVELOPMENTS IN NONLINEAR REACTOR DYNAMICS. Akhtar, Parvaiz. Ann Arbor, Mich.; Univ. of Michigan (1971). 103p. University Microfilms Order No. 72-14,787.

Thesis.

Stability of a point reactor with an arbitrary feedback is investigated. Some properties of the functionals representing feedback and various concepts of stability are discussed. A class of physically admissible initial curves representing possible intentional or accidental perturbations arising in the reactor is defined. Two theorems for boundedness and asymptotic stability in the reactor response to these physically admissible initial curves are developed. These theorems are applied to a reactor model with an arbitrary linear feedback and two specific cases where the Laplace transform of the feedback kernel is a transcendental function of s are considered. The theorems are also applied to a xenon-controlled reactor with flux reactivity coefficient γ and a region of asymptotic stability in the large in $P_0-\gamma$ plane is found. A criterion developed by M. C. Corduneanu is reproduced and is shown to be applicable to a reactor with an arbitrary linear feedback in the absence of delayed neutrons. (Diss. Abstr. Int., B)

40454 EXPERIMENTS FOR DETERMINING THE CRITICAL MASS OF A REACTOR CORE WITH MTR-TYPE FUEL ELEMENTS. Krull, W.; Wrobel, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Atomkernenergie; 19: No. 3, 259(May 1972). (In German).

Critical mass determinations of a reactor core comprising highly enriched (90%) MTR fuel elements show strong dependency of criticality on size, arrangement, and temperature of the moderator. Because of the fact that the active zone is only 29.5 × 32.5 × 60.0 cm^3, the effect essentially is caused by the high neutron loss from the core. Since the effect represents a good test for nuclear calculation methods, an experimental study of the dependency was performed. (tr-auth)

40455 STUDIES OF EPITHERMAL CELL PARAMETERS IN THE REACTOR LATTICES WITH MULTITUBE ENRICHED FUEL. Jozefowicz, Edward T. (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 16: No. 7-8, 367-76(1971).

The methods of measurement of epithermal cell parameters such as the epithermal-to-thermal fission ratio and resonance-to-thermal absorption ratio in ^{238}U in the reactor lattices with multitube enriched fuel are described. The interpretation of the experimental results in the frames of the infinite multiplication factor is given and simple methods of calculating the reasonance escape probabilities in ^{235}U and ^{238}U based on collision probability considerations for the cells with complicated structure are presented. The results are given and discussed for several types of lattices, viz. water moderated (WWR-SM normal and diluted), graphite and water moderated (ANNA with water), graphite moderated (ANNA without water), and beryllium and water moderated (MR type). 10 references. (auth)

Core Thermal Hydraulics

40456 MEASUREMENT OF THE LOCAL VOID FRACTION AT HIGH PRESSURE IN A HEATING CHANNEL. Martin, Robert (CEN, Grenoble, France). Nucl. Sci. Eng.; 48: No. 2, 125-38 (Jun 1972).

The results of an experimental study of the void fraction at high pressure (80 to 140 kg/cm^2) in two rectangular channels (5 × 0.2 and 5 × 0.28 cm) simulating a subchannel of a nuclear reactor plate-type fuel element are presented. The method enabled the distribution of the local void fraction in a cross section to be measured at about 100 locations; from these local values it was possible to determine accurate mean values and to precisely quantitate the influence of the parameters: pressure, mass velocity, and heat flux. This distribution of void fractions, among the first to be determined in this range of pressures, was obtained from 120,000 systematic, individual measurements, sufficient to allow accurate interpolations in the experimental region under consideration which included subcooled conditions. These results enabled testing certain models presented in the literature. Analyses with the Bowring model, for example, are in good agreement with present experimental data at 80 kg/cm^2. 19 references. (auth)

GENERAL

Law

40457 (INIS-mf-233) TWENTY-FIFTH ANNUAL REPORT OF THE ATOMIC ENERGY CONTROL BOARD OF CANADA, 1970–1971. (Atomic Energy Control Board, Ottawa (Ontario)). 1971. 50p. (In English and French). INIS.

The Atomic Energy Control Board was constituted in 1946 by the Atomic Energy Control Act. Its role as defined in the preamble to the Act is "to make provision for the control and supervision of the development, application and use of atomic energy, and to enable Canada to participate effectively in measures of international control of atomic energy which may hereafter be agreed upon." In its annual report for 1970–1971, the board reports on the following topics: organization; international developments; strategic atomic energy materials; radioisotopes; reactor licensing; other nuclear plants; accelerator safety; special fissionable substances; transportation of radioactive materials; atomic energy legislation; and assistance to universities. A financial statement for the fiscal year ending March 31, 1971 is included. (INIS)

40458 (ORO–2401-46) INTERACTIVE IMAGE MANIPULATION SYSTEM AND IMAGE MANIPULATIVE EXTENSION TO HIGHER LEVEL LANGUAGE FOR USE BY NONCOMPUTER ORIENTED PERSONNEL. Erickson, Jon; Wilson, Shelburne (Vanderbilt Univ., Nashville, Tenn.). 1972. 15p. (CONF-720430–2). Dep. NTIS.

From second symposium on the sharing of computer programs and technology in nuclear medicine; Oak Ridge, TN. (21 Apr 1972).

Two attributes that should be a part of the computational capability of any nuclear medicine facility attempting to perform a significant amount of experimental manipulation and processing of radioisotope images are the ability to obtain and use the large number of image-manipulation programs that evolve in such a system and the ability to produce rapidly specialized image analysis programs for specific analysis problems encountered in the course of a single research project. Both of these capabilities should be available to the noncomputer-oriented as well as the technical personnel. An interactive manipulation system that provides the first of these capabilities and an extension to higher-level languages that provides the second are described. (11 figures) (R.W.R.)

Miscellaneous

40459 (AAEC/TM–608) INCLINED SPECIMEN CARTRIDGE FOR USE IN THE JEM-7A GONIOMETER STAGE. Blake, R. G.; Kelly, P. M.; Warren, R. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1971. 5p. Dep. NTIS (U. S. Sales Only).

40460 (AE–446) PERSONNEL DOSIMETRY AT STUDSVIK DURING 1970. Hedlin, L.; Widell, C.-O. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Feb 1972. 9p. Dep. NTIS (U. S. Sales Only).

40461 (AECL–3955) SOME ASPECTS OF THE PLANT ECOLOGY OF AN OLD-FIELD. Turner, B. N.; Iverson, S. L.; Walley, W. J. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Mar 1972. 38p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

40462 (AREAEE–126) SPECTROPHOTOMETRIC QUANTITATIVE YIELD DETERMINATION OF ANTIMONY. Allam, S.; Zakaria, N.; Abdel-Rassoul, A. A. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Chemistry Dept.). 1971. 25p. Dep. NTIS (U. S. Sales Only).

40463 (AREAEE–128) ANION EXCHANGE STUDIES OF TIN(IV) COMPLEXES WITH SOME CARBOXYLIC ACIDS. Allam, S.; Abdel-Rassoul, A. A. (Atomic Energy Establishment, Cairo (Egypt). Nuclear Chemistry Dept.). 1971. 31p. Dep. NTIS (U. S. Sales Only).

40464 (AWRE/LIB/BIB–23) LIST OF UNCLASSIFIED PUBLICATIONS AND AWRE REPORTS BY STAFF OF THE WEAPONS GROUP PUBLISHED DURING THE YEAR 1971. Every, R. S.; Collison, R. I. (comps.) (Atomic Weapons Research Establishment, Aldermaston (England)). Apr 1972. 29p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

40465 (BNWL-SA–3458) NDT APPLICATIONS OF A PULSED LASER SCHLIEREN SYSTEM. Newman, Dennis R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar 1971. Contract AT(45-1)-1830. 27p. (CONF-710319–2). Dep. NTIS.

From Conference of the American Society of Nondestructive Testing; Los Angeles, Calif. (8 Mar 1971).

40466 (CEA-R–4293) HIGH-TEMPERATURE CREEP OF SINGLE CRYSTALLINE SODIUM CHLORIDE. Poirier, Jean-Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1972. 94p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

40467 (CGS–746-123) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN, JUNE 1971. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 152p. Dep. NTIS.

40468 (CGS–746-124) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN, JULY 1971. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 161p. Dep. NTIS.

40469 (CGS–746-125) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN, AUGUST 1971. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 149p. Dep. NTIS.

40470 (CGS–746-126) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN, SEPTEMBER 1971. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 97p. Dep. NTIS.

40471 (CGS–746-127) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN, OCTOBER 1971. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 85p. Dep. NTIS.

40472 (CGS–746-129) ALEUTIAN SEISMIC PROGRAM. SEISMOLOGICAL BULLETIN, DECEMBER 1971. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 84p. Dep. NTIS.

40473 (CGS–746-130) ALEUTIAN SEISMIC PROGRAM SEISMOLOGICAL BULLETIN, JANUARY 1972. (National Oceanic and Atmospheric Administration, Rockville, Md. Environmental Research Labs.). Jun 1972. Contract AT(29-2)-746. 78p. Dep. NTIS.

40474 (CISE-N–151) OPFIT: AN INTERACTIVE PROGRAM FOR FUNCTION APPROXIMATION AND BEST FITTING. Pierini, G.; Spedicato, E. (Centro Informazioni Studi Esperienze, Milan (Italy)). Mar 1972. 36p. Dep. NTIS (U. S. Sales Only).

40475 (CONF-720430–3) SOME GUIDELINES FOR DOCUMENTATION PRACTICES AS AN AID IN THE SHARING OF COMPUTER PROGRAMS AND TECHNOLOGY. Maskewitz, Betty F.; McClain, W. J. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 9p. Dep. NTIS.

From second symposium on the sharing of computer programs and technology in nuclear medicine; Oak Ridge, TN. (21 Apr 1972).

40476 (CONF-720523–2) ANODIC DISSOLUTION OF TITANIUM IN ACIDIC SULFATE SOLUTIONS. Kelly, Eugene J. (Oak Ridge National Lab., Tenn.). 1972. 24p. Dep. NTIS.

From fifth international congress on metallic corrosion meeting; Tokyo, Japan (21 May 1972).

40477 (CONF-720533–1) VARIABLE-VALUED LOGIC SYSTEM AS APPLIED TO PICTURE DESCRIPTION AND RECOGNI-

TION. Michalski, Ryszard S. (Illinois Univ., Urbana. Dept. of Computer Science). [1972]. 25p. Dep. NTIS.
From Conference on graphic languages; Vancouver, B. C. (22 May 1972).

40478 (CONF-720702-1) AGING OF THE IMMUNE SYSTEM: A BRIEF SUMMARY OF CURRENT KNOWLEDGE AND A RECOMMENDATION FOR FUTURE STUDIES. Makinodan, T. (Oak Ridge National Lab., Tenn.). [nd]. 6p. Dep. NTIS.
From ninth international Congress of Gerontology; Kiev, USSR (2 Jul 1972).

40479 (COO-1112-63) REGULARITY IN THE CRITICAL PHENOMENA. Tomozawa, Yukio (Michigan Univ., Ann Arbor. Dept. of Physics). Apr 1972. 12p. (UM-HE-72-10). Dep. NTIS.

40480 (COO-1469-202) HARDWARE/SOFTWARE INTERFACE FOR THE STEREOMATRIX DISPLAY. Cunningham, Ian MacDonald (Illinois Univ., Urbana. Dept. of Computer Science). Jun 1972. Contract AT(11-1)-1469. 51p. Dep. NTIS.
Thesis.

40481 (COO-1599-54) PRODUCTIVITY AND ROLE OF AQUATIC MACROPHYTES IN LAKES: AN ASSESSMENT. Wetzel, Robert G.; Hough, Richard A. (Michigan State Univ., Hickory Corners. W. K. Kellogg Biological Station). 1972. Contract AT(11-1)-1599. 21p. (CONF-720620-1). Dep. NTIS.
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Germanic	ä appears as	ae
Germanic	ö	oe
Germanic	ü	ue
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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Technical Information Center* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are the names of specific materials, things, and processes. Each heading is followed by a modifier that describes the properties of, or processes applied to, that heading.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MESONS
MESONS (π)
MESONS (rho)
1-PENTANOL
2-PENTANOL
URANIUM OXIDES
URANIUM OXIDES UO_2

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—*sorption by charcoal,* should be read *hydrogen sorption by charcoal.* As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—*yields in radiolysis of ethyl ether, effects of deuterium on,* should be read *effects of deuterium on formaldehyde yields in radiolysis of ethyl ether* and URANIUM—*crystal structure of, effect of cooling rate on allotropic transformations in,* should be read *effect of cooling rate on allotropic transformations in crystal structure of uranium.*

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Complex organic compounds occur in such variety as to require a systematic nomenclature. Headings for most substituted organic compounds are found in an inverted form following names of the parent compounds. Examples of two such headings are:

```
2,4-HEPTANEDIONE
2,4-HEPTANEDIONE, 1-PHENYL-
```

Headings are included for broad class names of enzymes, e.g., HYDROLASES and TRANSFERASES. Specific enzyme names are to be found in modifiers under these headings. Similarly, broad class names for hormones are included as headings, except in this case the headings are entered in the inverted form as, e.g., HORMONES, ADRENAL and HORMONES, SEX. The more specific names of hormones are to be found in the modifiers under the appropriate broad headings.

For compounds used as drugs, an effort is made to use subject headings that reflect the recommendations of the USAN (United States Adopted Names) compilation or the "New Names" columns of the *Journal of the American Medical Association*. The *Merck Index* has also been used in selecting subject headings for drugs.

Nomenclature of Life Sciences

Except for those in the phylum Tracheophyta, subject headings for plants are common names. For example, ALGAE, FUNGI, SLIME MOLDS, MOSSES, and LIVERWORTS are subject headings. The phylum name TRACHEOPHYTA and several classes and subclasses belonging to it are entered as subject headings. The specific classes entered are PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA, and PTEROPSIDA. The three subclasses FILICINIDAE, GYMNOSPERMIDAE, and ANGIOSPERMIDAE which belong under Pteropsida are also subject headings. Scientific names (genus and species) and common names if known are used in the modifying phrase.

Subject headings for microorganisms are VIRUSES, RICKETTSIA, and BACTERIA. The name of the type or kind of virus or the genus and species names of the organisms should appear in the modifying phrase.

The names of animal phyla are subject headings. The arthropods are also indexed to subject headings for classes INSECTA, CRUSTACEA, ARACHNIDA, DIPLOPODA, and CHILOPODA. The invertebrate chordates are indexed to subject headings UROCHORDATA and CEPHALOCHORDATA. The vertebrates are indexed to headings for the classes AGNATHA, CHONDRICHTHYES, OSTEICHTHYES, AMPHIBIA, REPTILIA, AVES, and MAMMALIA as well as to the general heading VERTEBRATA. Common names are used as subject headings in the class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

```
Example 1          Example 2

CEREALS            MEATS
  bread              beef
  flour              fish
  oats               mutton
  rice               pork
  rye                poultry
  wheat              seafood
```

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are common names such as ANEMIA, FIBROSIS, INFECTIONS, LEUKEMIA, NEOPLASMS, and RADIATION SICKNESS. Also, the general headings DISEASES and DISEASES, PLANTS are available as subject headings.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except those with well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

```
ACETIC ACID
  acetic acid--BF3, ...
BORON FLUORIDES
  acetic acid--BF3, ...
```

Example:

```
BENZENE, CHLORO-
  bromophenol--chlorobenzene, ...
PHENOL, BROMO-
  bromophenol--chlorobenzene, ...
```

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

```
ALUMINUM OXIDES
  Al2O3--Cu, ...
COPPER ALLOYS AND SYSTEMS
  Al2O3--Cu, ...
```

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

```
CARBON SYSTEMS
  deposition on nuclear fuel
    particles
  molecular structure of
  neutron total cross section for
  sorptive properties for xenon
  Young's modulus for
  Al--C--Cr, superconductivity in
  B--C, phase studies for
  C--U--Zr, fabrication and
    physical properties of
```

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of the Particle Data Group published in *Review of Particle Properties* (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: $\Lambda\text{-He}^5$, $\Sigma\text{-H}^3$, $\Lambda\Lambda\text{-Be}^{10}$. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

```
MESONS (π-)
  interactions π- + p → Λ + K+ + π- at 6 GeV/c in
    hydrogen bubble chamber, ΛK(1700) enhancement
    in, (E)
BARYONS, RESONANCE (Δ)
  production of Δ++(1236) and Δ0(1236) from K- +
    p → K- + p + π+ + π- interactions at 2.63 and
    2.70 GeV/c, (E)
HYPERNUCLEI
  binding energy of ΛΛ-He6, three-body α--Λ--Λ
    model for
```

Subject headings are also provided for specific models and theories.

Examples:

```
ELEMENTARY PARTICLE MODELS
  quark, hadron total cross sections in,
    numerical analysis of
CURRENT ALGEBRA
  PCAC hypothesis for A1 and rho dominance in π →
    e + ν + γ decay
REGGE POLE THEORY
  predictions for polarization in K- + p → anti
    K0 + n, π- + p → π0 + n, and π- + p → eta + n
    interactions at high energies
SYMMETRY GROUPS
  SU(2) x SU(4) intermediate-coupling model for
    nucleon and hyperon isobars
```

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (2) or (3) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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Conferences

Published conference proceedings as well as individual unpublished papers from conferences are included in this index. A CONF number is assigned to the conference if published proceedings are received and also if only a single paper is received. The base number used is year-month-sequence. Thus, the number CONF-650101 indicates that the conference was held in 1965, in January, and that this was the first January 1965 conference so received. This number would be assigned to complete published proceedings. If individual papers are received, the base number is extended to include a paper number, e.g., CONF-650101-1. As additional papers are received, they will be assigned consecutive numbers in the series, CONF-650101-1, CONF-650101-2, etc. This numbering system ensures that all papers received from a conference will be associated with that conference in this index.

If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

Abbreviations Used in Availability Column

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CFSTI	See NTIS
DENM	Reports of the Atomic Energy Commission Research Establishment, Risö, are available on exchange from the Library, Danish Atomic Energy Commission, Risö, Roskilde, Denmark. Also for sale at the price shown from Jul. Gjellerup, Booksellers, 87 Sölvgade, Kobenhavn K., Denmark. Reports of Danatom are available on loan from Research Establishment, Risö, Roskilde, Denmark. Copies are available from Danatom, Aurehojvej 2, Hellerup, Denmark.
Dep.	AEC reports so designated are maintained in the organizations listed on the inside front cover of *NSA*. Prior to July 1, 1965, reports were deposited either in printed copy form or in microform. After that time, all reports have been in the form of micronegatives. Reports from other countries so designated are available in the United States at the organizations listed on the inside front cover of *NSA*.

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EM	Blueline prints of AEC engineering drawings are available from NTIS, U. S. Department of Commerce, Springfield, Virginia 22151. Current prices of the CAPE-packages may be obtained from this address. TID-4100, available from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830, contains information on all the CAPE packages for sale.
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GPO	For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.
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NORW	Reports from Forsvarets Forskningsinstitutt are available from Norwegian Defense Research Establishment, Library, P. O. Box 25, Kjeller, Norway. "KR" reports are available on an exchange basis from the Library, Institutt for Atomenergi, Box 40, Kjeller, Norway. Reports of the Norwegian Reactor School are available from the Library, Institutt for Atomenergi, P. O. Box 40, Kjeller, Norway.
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	26-39398	Moscow; All-Union Institute of Scientific and Technical Information (1967). 236p
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1	26-40530	See RFP-Trans-100
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	26-40202	Tokyo; Atomic Energy Society of Japan (1970). 90p
CONF-700450-	(Conference on Radiation Protection, Berlin, Germany, Apr. 21-22, 1970)	
	26-40214	Munich; Verlag Karl Thiemig KG

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CONF-700571-		(International Symposium on Solar-Terrestrial Physics, Leningrad, U.S.S.R., May 12-19, 1970)
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1	26-40537	See SC-DC-70-5465
CONF-710319-		(Conference of the American Society of Nondestructive Testing, Los Angeles, Calif., Mar. 8-12, 1971)
2	26-40465	See BNWL-SA-3458
CONF-710349-		(Hematopoietic and Gastrointestinal Investigations with Radionuclides Conference, Miami, Fl., Mar. 3-7, 1971)
	26-38809	Springfield, Ill.; Charles C Thomas, Publisher (1972). 468p. $30.00
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	26-40252	Instrum. Power Ind.; 14: 1-101(1971)
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1	26-40438	See AEEW-M-1048
CONF-710816-		(International Symposium on Electron and Photon Interactions at High Energies, Ithaca, N.Y., Aug. 23-27, 1971)
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3	26-39018	See EUR-4799
4	26-38441	See EUR-4801
CONF-710952-		(Symposium of the Italian Thermotechnical Association, L'Aquila, Italy, Sept. 21, 1971)
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CONF-711021-		(International Conference on Multiply-Charged Heavy Ion Sources and Accelerating Systems, Gatlinburg, Tenn., Oct. 25-28, 1971)
	26-39063	IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 2, 1-335(Apr 1972)
CONF-711104-		(Symposium on the Assessment of Radioactive Organ and Body Burdens, Stockholm, Sweden, Nov. 22-26, 1971)
4	26-38752	See ORO-2401-51
CONF-711112-		(Annual Meeting of American Society of Mechanical Engineers, Washington, D.C., Nov. 28-Dec. 1, 1971)
7	26-40486	See COO-2032-10
CONF-711134-		(Conference on the Defectoscope, Prague, Czechoslovakia, Nov. 8-11, 1971)
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CONF-711141-		(57th Annual Meeting of The Radiological Society of North America, Chicago, IL., Nov. 28-Dec. 3, 1971)
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	26-38565	New York; Institute of Electrical and Electronics Engineers, Inc. (1972). 255p
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6	26-40546	See SC-DC-721262
CONF-720517-	(SESA Spring Meeting, Cleveland, OH., May 23-26, 1972)	
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CONF-720518-	(9th IEEE Photovoltaic Specialist Conference, Silver Spring, MD., May 1972)	
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1	26-40490	See COO-3013-48
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1	26-40538	See SC-DC-714102
2	26-40542	See SC-DC-721005
CONF-720528-	(19th International Technical Communication Conference, Boston, MA., May 10-13, 1972)	
1	26-40545	See SC-DC-721203
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